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UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org

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Project Report on

TF/BRA/92/B10 : ASSISTANCE IN THE ESTABLISHMENT OF THE CENTRE FOR MANAGEMENT METHODS OF STATISTICAL PROCESS CONTROL (PHASE I):

CONTRACT NO.94/003

February, 1996

Union of Japanese Scientists and Engineers(JUSE)

SYNOPSIS OF ABSTRACT

Under the Contract (No.94/003) with UNIDO on the Project titled "the Assistance in the Establishment of the Centre for Management Methods of Statistical Process Control - Phase I"(UNIDO Project No.TF/BRA/92/B10), as the subcontractor JUSE has conducted the following three kinds of actions for the Project to help the Carlos Vanzolini Foundation(FCAV), the University of Sao Paulo, to establish a TQC training centre called the Centro Internacional para Productividade e Qualidade(CIPQ) Sao Paulo, in Brazil.

(1) Preliminary evaluation of managerial systems currently in use in Brazilian manufacturing: To be specified, a survey for TQC (Total Quality Control) implementation status was carried out by visiting a number of manufacturing firms that were selected by FCAV. In general, it was revealed that full scale of TQC-concept-education programme were necessary to conduct Brazilian Industry fields.

(2) Two-week TQC training of 6 Brazilian faculty from FCAV at JUSE in Japan: The training consisted of a seminar and lectures covering overall TQC concepts and methodologies for one week and plant visits for another week. The purpose of the training programme was to make the six faculty of FCAV familiar with the Japanese approaches in the implementation of TQC. To be more specified, the training focused on the latest thoughts, concepts and techniques of TQC that generally adapted in daily operations of Japanese companies. As the result, however, it was revealed that unless further extensive refreshing courses were organized by JUSE, the supports as subcontractor to the Brazilian industry or CIPQ would not be sufficient enough in the implementation of TQC.

(3) Three-day seminar as a TQC orientation programme for Brazilian top management: With a FCAV's arrangement, the seminar was organized in a hotel in Sao Paulo inviting Brazilian industry's top management. The aim of the seminar was to inspire top management in Brazilian industry the necessity of TQC by showing its concept, the implementation cases, and the methodology. It was revealed that not only top management but middle-management and facilitators need to receive intensive TQC training if Brazilian industry is to fully understand survival and predominant competition enhancement necessity.

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1. INTRODUCTION

1-1. SUBJECTS OF THE REPORT

(1) JUSE functioned as the "subcontractor" of the UNIDO project of TF/BRA/92/B10 to support FCAV. At the outset for this purpose, according to the subcontractor's Terms of Reference of the project, JUSE sent two TQC specialists to Brazil from September 26 to October 6, 1994, for the preliminary evaluation aiming at making a status survey in Brazilian industry and recommending the education schemes for professional facilitators of FCAV.

(2) From March 6 to 17, 1995, TQC implementation seminar for six selected faculty members of FCAV was organized as two-week education programme. The first week from March 6 to 10 was a seminar in class-room type and the other week from March 13 to 16 was plant visits to verify TQC implementing status at site.

(3) Under the complementary UNIDO project (DP/BRA/92/004) with the same title, three-day seminar as TQC orientation programme for Brazilian top management was organized on September 12, 13 and 14, 1995, in Sao Paulo, to have them being familiar with TQC concepts implementation procedures.

1-2. PURPOSES OF EACH ACTIVITY

(1) Two-week preliminary evaluation

It was organized to identify and verify how the Brazilian firms currently implement TQC. Other purposes were to collect some kinds of quality related information, and to establish education curriculum for FCAV faculty.

The report on the preliminary evaluation refers to the JUSE specialists' identification and verification of current problems and conditions in Brazilian industry, and suggestions of developing quality improvement activities in the industry. Also, the education programme for six faculty members of FCAV for 2 weeks in Japan was developed.

(2) TQC implementation seminar for six faculty members of FCAV, from March 6 to 17, 1995

The report is to fill in the detailed contents of the seminar and the plant visits programme with the seminar materials. It is important to refer to the six faculty's feedback after receiving the TQC implementation seminar.

(3) Three-day seminar as TQC orientation programme for Brazilian top management on September 12, 13 and 14, 1995, in Sao Paulo

The report is to fill in the curriculum of the seminar as well as a brief observation of the seminar. It is important to refer to JUSE specialist's comments and recommendation to the seminar.

1-3. PLAN OF TREATMENT

As mentioned in 3. Body, 3-1. General Terms of Reference Implementation, this programme of TF/BRA/92/B10 started with preliminary evaluation by two JUSE TQC specialists. Based on the evaluation, the follow-up training programmes for FCAV's faculty (Two-week TQC Training programme) and Brazilian industry personnel (Three-day seminar in Brazil) were made. For this procedure, the both programmes took the situations of current Brazilian TQC activities into consideration. For example, the two-week TQC training programme's subjects were selected by the two specialists.

2. PRELIMINARY SECTION

2-1. TWO-WEEK PRELIMINARY EVALUATION

Ten companies out of the eleven companies selected by FCAV were visited by two JUSE specialists to identify their TQC implementation or understanding status among the top/senior management. Through this survey, it became apparent that TQC concept is not fully implemented yet in Brazilian industry and that mostly the inspection oriented methods are used.

More specifically;

- None of top management commit for survival or predominated competition.

- No systematic and scientific management programmes are implemented for customer satisfaction.

- Quality improvement awareness in their responsibility is not assigned to each workshop, nor familiar with necessary corrective action by statistical methodology.

- Middle-management are neither challenged nor motivated with continuous improvement better than competitors' situation (bench marks) in their daily routine work.

2-2. TWO-WEEK TRAINING PROGRAMME

- It is felt that a continuous programme for the six FCAV faculty members be necessary to bring up them to the core persons of CIPQ.

2-3. THREE-DAY SEMINAR FOR BRAZILIAN TOP MANAGERS

- The seminar could conclude that Brazilian industry is surely interested in TQC concept and implementation programme and keen to understand them. However, at this stage, some misunderstandings are apparent among them so that the follow-up programmes are necessary to encourage them continuously and have them understand up to the level for surviving global competitions.

3. BODY

3-1. GENERAL TERM OF REFE..ENCE IMPLEMENTATION STATUS

JUSE has implemented the activities of TF/BRA/92/B10 to carry out the subcontractors' terms of reference(TOR) with the following schedule:

Activities	Schedule
TOR Output 1: Customized Teaching Material for Use at CIPQ	
- Preliminary evaluation (1-a. and 1-b.)	
1-a. Two specialists from JUSE attend briefing and coordinative meeting with staff of FCAV (one week) 1-b. After 1-a. the two specialists receive orientation and evaluate the quality control systems in major industries, and interview manufacturers (one week)	September 26, to October 6, 1994 (2 weeks)
1-c. Preparation of training programmes and course material in Japan (English version)	After 1-a. and 1-b. till the following 2-a. and 2-b.
TOR Output 2: Trained Brazilian Faculty in the Field of TQC	
- Two-week TQC training programme (2-a. and 2-b.)	
2-a. 1 week TQC Seminar in Japan	March 6 to 10, 1995
2-b. 1 week Plant Visit in Japan	March 13 to 17, 1995
TOR Output 1: Customized Teaching Material for Use at CIPQ (continued)	
Completion of Material (English version) for Use at CIPQ, and submitting them to UNIDO and CIPQ	End of May, 1995
- Three-day Seminar in Brazil(under the UNIDO project (DP/BRA/92/004)	September 12, 13 and 14, 1995
- Completion of draft final report	End of September, 1995

Initially, the order of the activities plan were briefly 1.Preliminary evaluation, 2.Three-day seminar in Brazil, and 3. Two-week TQC training programme. However, JUSE experts considered bringing up CIPQ faculty as early as possible to be the key of successful establishment of CIPQ. So JUSE recommended to change the order that Two-week TQC training programme come after Preliminary evaluation followed by Three-day seminar in Brazil at the end of the project. JUSE experts thought that putting Three-day seminar in Brazil in the last timing of the project activities would enable the JUSE team to check the increase in capability of CIPQ's faculty after the two-week training.

3-2. DETAILS OF EACH ACTIVITY

3-2-1. Activity 1: Preliminary Evaluation by two JUSE specialists from September 26 to October 6, 1994, in Brazil

3-2-1-1. Purpose of the Preliminary Evaluation

The prime objectives of the Evaluation Survey were to identify what kinds of education are necessary for TQC facilitators in FCAV in view of the attainment of Brazilian industry's products to the world-level quality, judging from both management-level personnel awareness on TQC concept implementation and QC practice for customer satisfaction concept implementation in the production area.

3-2-1-2. General Statement for Survey Programme

A) As mentioned below, the survey programme consisted of the two parts to identify.

1) To investigate how much TQC concepts are fully understood, implemented and evaluated for customer satisfaction/competition dominancy/survival accomplishment as company-wide programme among top management, senior/middle management and supervisors/ administrative staff/operators. (Mr. I. Miyauchi was responsible for this part.)

2) To identify how much quality control programme is effectively implemented among production managers, and to assure product quality and to improve continuously its quality for competitive world-level achievement. (Mr. H. Yoshikawa was responsible for this part.)

B) The companies being surveyed were picked-up by FCAV from their client list as shown in the attached sheet (Appendix 1).

C) All the planned visits to the selected companies except the Hoechst do Brasil were carried out as stated schedule in Appendix 1. However, the overall schedule was quite tough and hectic: only two or three hours staying at each company's facility so that the two experts had to confront the limited time barriers due partly to the vast country's transportation difficulty.

D) Despite such difficulty, the mission was accomplished with satisfactory as scheduled.

3-2-1-3. Surveying Procedure and Results on TQC Concept Understanding and Implementing Status (conducted by Mr. I. Miyauchi)

A) Survey on TQC Concept

1) To evaluate the above mentioned, check-sheets (see Appendix 2) and an assessment sheet (see Appendix 3) were prepared for identification of the status.

2) During each company visit, Mr. Miyauchi questioned each subject mentioned in the check-sheets to top management and/or senior management. However, time limitation made it difficult for Mr. Miyauchi to interview operators as planned. As for the staff/engineering level, only two cases were accomplished within the schedule.

3) When a top manager was not available, the questions were asked to one or several senior managers assuming that their answers would represent top managers'.

4) The score for the check-sheets evaluation is organized by 0-5 levels as:

0-----1-----2-----3-----4-----5

where
- 0: Nothing issued, implemented, nor performed
- 1: Only a few are implemented with objective evidences
- 2: Less than 50% of organization are implemented, with objective evidences
- 3: 50-79% of organization are implemented with objective evidences
- 4: 80-94% of organization are implemented with objective evidences
- 5: 95-100% of organization are implemented

5) Summarization sheets (Appendix 4) were prepared to show the results of the TQC implementation status at a glance.

6) The results of the TQC concept survey from the summarization sheets with respect to TQC implementation. The following items respond to the check sheets(i.e. 1-A) responds to 1. For Top Management A) in Appendix 2). The items 1-A) to 1-Z) were questioned to top management. The 2-A) to 2-W) were to senior and middle management. As mentioned before, the 3-A) to 3-R) were supposed to be asked to employees(operators, staff, engineers, and others), however, there was not enough time to carry out.

1-A) In 7 out of 10 companies the top managers do not have firm commitment for survival/competition concept dissemination.

1-B) In 3 out of 10 companies the top managers do not have any clear customer satisfaction philosophy.

1-C) In 5 out of 10 companies the top managers do not have either a clear company's horizon or a vision for the future.

1-D) In 5 out of 10 companies the top managers have a strategy but only for financial profit generation.

1-E) In 7 out of 10 companies the top managers have long, medium and annual plans and objectives relating to financial profit generation.

1-F) In 8 out of 10 companies the top managers have not established an independent TQC office and not assigned specific responsible personnel for facilitation.

1-G) In 6 out of 10 companies the top managers have long, medium or annual objectives.

1-H) In 7 out of 10 companies the top managers take international changes into account.

1-I) In 6 out of 10 companies the top managers do not understand "Vital few" concept yet.

1-J) In 5 out of 10 companies the top managers have not deployed TQC to their substructure, accordingly TQC has not disseminated yet.

1-K) In 5 out of 10 companies the top managers have not established procedures to achieve their policies and objectives.

1-L) In 3 out of 10 companies the top managers evaluate their status fully.

1-M) In 6 out of 10 companies the top managers do not verify their workshop's problems including their top management.

1-N) In 7 out of 10 companies the top managers do not have such programme as mutual communications.

1-O) In 5 out of 10 companies the top managers do not pay attention to previous-year feed-back.

1-P) In 6 out of 10 companies the top managers do not implement continuous improvement persuasion by their top management.

1-Q) In 9 out of 10 companies the top managers do not usually achieve 100% for achievement objectives as planned.

1-R) In 9 out of 10 companies the top managers do not implement a daily routine work management programme.

1-S) In 8 out of 10 companies the top managers do not implement a personnel involvement programme on business management.

1-T) In 6 out of 10 companies the top managers do not implement a personnel recognition programme such as an awarding system establishment.

1-U) 1) to 5) In 7 out of 10 companies the top managers do not specifically evaluate their productivity, competitiveness, growth rate and risk management but profitability compared with the competitors.

1-U) 6) a.to f. In 8 out of 10 companies the top managers do not fully evaluate on Customer Satisfaction in terms of Quality, Cost/Price, Delivery, Safety, Environment Production and Human Resource Development compared with the competitors.

1-V) In 3 out of 10 companies the top managers have not installed customer information collection programme.

1-W) In 5 out of 10 companies the top managers do not evaluate for future programme on information for measuring and corrective actions.

1-X) In 5 out of 10 companies, the top managers do not involve leadership for customer claim/complain handling.

1-Y) In 7 out of 10 companies the top managers do not fully educate their employees such concepts as (1) to (11) (See Appendix 2. page 2) yet.

1-Z) In 6 out of 10 companies the top managers do not install QC circle activity.

2-A) In 6 out of 6 companies the senior and middle managers do not understand their system for business management policy and objective establish programme.

2-B) In 5 out of 6 companies the senior and middle managers understand their top management's business philosophy.

2-C) In 4 out of 6 companies the senior and middle managers understand their top management's quality commitment based on Customer Satisfaction under TQC concepts such as 1-Y) (1) to (11) (See Appendix 2. page 2).

2-D) In 5 out of 6 companies the senior and middle managers have not established their own philosophy and commitment.

2-E) In 2 out of 6 companies the senior and middle managers have established their own customer role, responsibility and participation scope because they are quality managers who are responsible for establishing them based on ISO 9000.

2-F) In 5 out of 6 companies the senior and middle managers do not establish their own specific objectives to perform their top management's objectives.

2-G) In 5 out of 6 companies the senior and middle managers do not establish customer satisfaction programme.

2-H) In 5 out of 6 companies the senior and middle managers have established S. O. Ps(Standard Operating Procedures).

2-I) In 5 out of 6 companies the senior and middle managers satisfactorily train employees for S.O.Ps.

2-J) In 1 out of 6 companies the senior and middle managers answered that their subordinates fully recognize their responsibility in the daily routine-work, but rather higher failure-rate at the workshops.

2-K) In 5 out of 6 companies the senior and middle managers do not teach QC story programme for their daily routine-work improvement or corrective action.

2-L) In 4 out of 6 companies the senior and middle managers said their companies organize some sort of horizontal level management communications programme.

2-M) In 4 out of 6 companies the senior and middle managers have coordinated their consisted and compatible plan objectives with horizontal level management.

2-N) In 2 out of 5 companies the senior and middle mangers implement mutual communications programme with the same level managers.

2-O) In 2 out of 6 companies the senior and middle managers do not implement QC story.

2-P) In 3 out of 6 companies the senior and middle managers utilize QC 7 tools on their workshops.

2-Q) In 5 out of 6 companies the senior and middle managers do not establish any specific problem-solution procedure.

2-R) In 6 out of 6 companies the senior and middle managers do not fully establish statistical method implementation programme.

2-S) In 3 out of 6 companies the senior and middle managers feed back the previous year's records.

2-T) In 3 out of 6 companies the senior and middle managers said that their plan and objectives are not fully achieved as planned.

2-U) In 5 out of 6 companies the senior and middle managers said that they contribute partially to their companies' business plans established by their top management.

2-V) In 2 out of 6 companies the senior and middle managers fully try to improve communications with their subordinates on daily routine-work and corrective actions.

2-W) In 4 out of 6 companies the senior and middle managers do not pay much attentions to the programme for environment and atmosphere improvement.

B) The evaluation of TQC implementation status based on the check sheets summarization (see Appendix 4), the followings are observed and evaluated in conjunction with their status in TQC implementation programme. Unfortunately only a few companies are implementing TQC. TQC Basic Seminars for top management, senior/middle management and facilitators are considered to be necessary.

1)Top Management

a) No survival or dominant-competition-development concepts are committed to progress for permanent prosperity of each company in a written form.

b) Some creed type statements exist at some companies, but are limited to financial related expression without specific vision or horizon for company's future images.

c) Business management plan for next 3-5 years are available only for financial related plans and the objectives are hardly touched on customer-satisfaction-related quality, cost, delivery, environment, and safety characteristics with specific measurable indexes.

d) The plans have not been deployed to the lower echelons to have the lowers participate in the achievement of such objectives under mandatory requirements. They have never been audited by the top management for their implementation status or trends account of full accomplishment of their objectives.

e) These established objectives are not prioritized for accomplishment under the vital-few concept, but just are handled for achievement.

f) Daily-routine work management programmes are not implemented yet. The programmes should be designed to enable their middle-management to devote to continuous improvement their daily routine-work under their own responsibility.

g) The established objectives are evaluated, on the annual basis, in terms of overall profitability competition, growth rate and risk status, but are not specifically evaluated from long-term viewpoint except for productivity.

h) The customer satisfaction status for quality, price, delivery, in the achievement of safety, environment protection and retention and the human resource development are not specifically measured and evaluated.

i) Such evaluation source-information collective systems have not been established although evaluation or corrective actions should be initiated based on such information.

j) The customer's claims and complaints are handled only by the quality management.

k) The TQC concepts such as market-in, internal customer, quality first, fact and data appreciation, vital-few, dispersion control, process control, recurrent prevention, human-oriented behavior control, employee participation, and upper stream control, are not fully diffused and these implementation status are very low or none at all.

l) Only a few companies are implementing QC Circle activities.

2) Implementation Programme

a) Any TQC promotional organization has not been established for TQC implementation programmes but some companies are located within/under a quality organization.

b) Any formal TQC education is not conducted for the top management, middle-management, and facilitators.

c) No facilitators are assigned to such physical promotional activities.

3) Implementation Status

a) Except one company, none of the companies implements TQC activities today. These companies, in general, consider mistakenly quality assurance programmes as TQC.

b) So is the same: ISO 9000 series accreditation is accepted as the maximum efforts for competition dominancy or meets with the enterprises' approval.

4) Middle-Management

a) As aforementioned in paragraph 1) Top Management, because of none-implementation of the daily routine-work management concepts, they are not able to deploy their responsible goals set by their top management, and not able to establish their own daily management goals by themselves based on their job description and their assigned functional responsibilities as middle management.

b) They are just confronting with and waiting for the top management instructions.

c) They have been only officially educated with TQC concepts and with implementation programmes.

d) Accordingly, they are familiarized with neither problem-solution procedures while utilizing QC 7 Tools nor statistical procedures.

e) They do not have specific human-relationship improving programmes with their own subordinates.

f) They do not have any specific environment and atmosphere programmes that are originated to their own ideas.

3-2-1-4. Survey Procedures on Production QC Status (conducted by Mr. H. Yoshikawa)

A) Production QC Status

As shown in Appendix 5, a survey check sheet was provided. The sheet was, however, initially prepared for objective evaluation of production quality control status in Japanese vehicle manufactures or component makers which already have enough knowledge of quality improvement, assurance of delivery schedule, and achievement of cost reduction objectives.

1) Specific consideration taken into the preparation

a) being able to evaluate with numerical values

b) being understandable by whoever involved including management and operators

c) being identifiable for responsibilities to be imposed

d) being utilizable continuously

e) being applicable to any work processes

2) Analysis of the evaluation results and beneficial utilization of these results

a) Based on the obtained evaluation results, companies can be classified into following categories:

A --- More than 90 points: The operational daily routine-work responsibility can be delegated to the operators

B --- 80-89 points: It is necessary to take corrective/improving actions by the assigned foreman

C --- 61-79 points: It is necessary to take corrective/improving actions by the assigned middle-management

D --- Less than 60 points: It is necessary to take corrective/improving actions by the assigned general managers

If the evaluation results are to be utilized, all responsible personnel (foremen, middle management and/or general management) are requested to prepare corrective/improving action plan to achieve higher evaluation points according to the quality control concepts, and to evaluate these results by every 6 months for effectiveness of the actions taken.

It is recognizable in this evaluation that the lower evaluation is taken, the higher management are requested to be involved in the corrective/improving actions for problem solution. This evaluation method is so different from the conventional management style that old type of managers often can not follow. On the contrary, newer type of managers are apt to accept easier and use it.

3) The purpose of this survey, and how to use the check-sheet (Appendix 5.) for their own evaluation

a) The participants were divided into groups 3-4 persons to evaluate their own workshop status by mutual discussion under free and unbiased atmosphere without interruption for one hour.

b) Accordingly, the evaluation obtained was based completely on their own self-decision and was not influenced by any other supplementation.

d) After the evaluation, the participants requested Mr. Yoshikawa's comments for comparison with the Japanese industries in the evaluation or quality control level of their companies. However, since this prime objectives were solely to obtain and identify the Brazilian TQC and production quality control status, Mr. Yoshikawa restrained such comments at this time.

4) The results of the Production QC status survey summarized Appendix 6 and 7

a) Appendix 6. (1)-(3): Summarization sheets show the results for Production QC Status in Brazilian industries at a glance.

b) Appendix 7: Summarization sheets the individual survey items being scored A to D.

5) Evaluation of QC Status in Production Area

a)In general, it was not possible to investigate every process status and trend based on such check-sheet analysis within very limited time. Mr. Yoshikawa tried to conjecture how the management in production area was aware of their workshop problems or status which were revealed in the data shown in Appendix 6. To verify or validate the comments, Mr. Yoshikawa will need to collect and summarize the data in workshops in the future.

b) Judging from Appendix 7.- Summarization table, it is noticeable that their major concerns are
(1) Customer-claim.
(2) High in-process failure rate, and
(3) Lower productivity.

c) They are generally not satisfied with their present status in in-processing and are trying to do something better.

d) With respect to actions taken on "Cause-side" elements and their awareness.

(1) They recognize the importance of standard operation procedures, daily check procedures, recording of controlling data, education and training, 5S, and control items in daily routine-work management. They are aware of themselves that they are managing these actions within their responsibility designated by company regulation.

(2) They recognize that their equipment, tool and jig, material and supplied components have some problems, but do not pay too much attention to problem controlling programmes.

(3) They recognize that QC circle activities are rather hard to implement. Most companies have not implemented QC Circle activities yet.

(4) In the business planning, most financial objectives have been established and disseminated by the top management. But they are considered as incomplete in most cases.

6) Reviewing QC Status in Production

a) With respect to management methodology and its implementation in Brazilian industry, it is quite recognizable that many kinds of common daily control methodology, such as European model, TQM, TQC, ISO 9000 series, TPM etc. have been adopted by Brazilian industries up to now because of geological and historical situations. Accordingly, every management is managing daily maintaining in the fields of present quality, cost and delivery through combined application of these methods. However, as prescribed, they are not satisfied with the present low level of QC application compared to the world-level.

b) Relationship between daily routine-work management and quality control

(1) Although they are managing their daily routine-work under specified standards and programmes, some quality problems without any solutions are recognized by every manager. It could be concluded that each manager thinks that such quality problems are not his/her own problems but somebody else's and that his/her complaints are

accumulated in his/her mind. Or they give up the solutions of these problems because they think that they are incapable to solve the problems.

(2) This kind of managers' attitude is sometimes observed in various industries when the level of the company's capability in production management has reached at a certain level of problem-solving capacity. The Brazilian production managers seem to have attained to this level. There are so many kinds of "causes" influencing product quality. The causes interact complexly. Their present technical levels and programmes of "cause" control is not sufficient enough to identify the root-cause as well as to establish controlling procedures and, therefore, recurrent failures tend to occur in production their workshops.

The only way to extricate from this weakness is nothing but to analyze every process to identify causes of the problem. No other royal roads are available today for the Brazilian industry.

To lead the Brazilian QC up to the level that they can accomplish internationally competitive product development, analyzing every process and identifying causes of the problem is the way for success.

Mr. Yoshikawa recognizes that the Brazilian top and middle management and production workshops have enough potential capability for improving and developing their products. He thinks that only if they fully and effectively display their capacity, the company would achieve the top-level quality competition.

3-2-1-5. Recommendation

A) For TQC Implementation

The training programme for top management, senior management, middle management and facilitators in each company should consist of two parts:

(i) class-room training

(ii) OJT which will be conducted at each company-site by the CIPQ staff with Japanese experts after (i) is finished.

a) Class-room training of top management should cover;

(1) TQC Concept
(2) TQC implementation objectives
(3) Top management responsibility on TQC implementation programme (management by policy and assessment)
(4) Customer satisfaction
(5) Quality assurance

(6) Standardization
(7) Collaboration with supplier
(8) International status on TQC implementation programme

b) Class-room training of senior and middle management should cover;

(1) TQC concepts and objectives
(2) TQC implementation objectives
(3) TQC implementation programmes
(4) Management by policy (I)
Cross-functional management
(5) Management by policy (II)
Daily routine-work management
(6) Standardization
(7) Quality assurance
(8) Collaboration with suppliers
(9) QC 7 tools
(10) QC methods (QC Story)
(11) Roles and responsibilities of management
(12) Quality deployment
(13) 5 S programme
(14) QC Circle activity
(15) International status on TQC implementation programmes

c) Class-room training of facilitators should cover;

(1) TQC implementation objectives
(2) TQC concepts in detail
- Control concept - not control by result, but in-process
- Market-in concept
- Internal and external customer satisfaction concept
- Quality first concept
- Upper stream control concept
- Vital few concept
- Data and fact appreciation concept
- Dispersion control concept
- Recurrent prevention concept
- Human oriented behavior concept
- Employees participation concept
(3) TQC implementation programmes with QC story
(4) Management by policy (I)
- Cross functional management
(5) Management by policy (II)
- Daily routine-work management
(6) Standardization
(7) Control item and check item identification
(8) Quality assurance
(9) QC 7 tool
(10) Roles and responsibilities of facilitators
(11) Roles and responsibilities of top management
(12) Roles and responsibilities of middle management
(13) Production industry implementation (case-study)
(14) Service industry implementation (case-study)
(15) New product development (case-study)

(16) Marketing and sales organization (case-study)
(17) Administration organization (case-study)
(18) Procurement organization (case-study)
(19) QC and QA organization (case-study)
(20) Production organization (case-study)
(21) Servicing organization (case-study)
(22) Maintenance organization (case-study)
(23) Reliability and maintainability engineering
(24) Product liability (case-study)
(25) Quality deployment techniques
(26) Design review techniques
(27) Failure mode effectiveness analysis: techniques and application
(28) Fault-tree analysis techniques and their application
(29) Management 7 tools

However, it is not realistic to assume that such vast subjects be covered in the first phase of the training programme: Subjects from (1) to (12) are essential to be covered, and the rest of the subjects will be performed as advanced courses in Phase II and III of the current project but depending on the CIPQ faculty's familiarization and capacity.

B) For Production QC Implementation

1) It is urgent to develop a quality improvement action programme by FCAV. This programme would consist of the following actions:

STEP	ACTION ITEM
1. Establish Clear Quality Improvement Strategy	1) Reduction of in-process failures 2) Reduction of claims 3) Smooth transition to mass-production phase on new product development 4) Expedition of R & D
2. Establish Strong Motivation	1) Establishment of quantitative objecttives (e.g. failure reduction of 10% or 20%) 2) Establishment of a definite programme (to be achieved within 6 months or 1 year) 3) Assignment of strong top management 4) Assignment of management as a leader 5) Continuous company-wide education by CIPQ 6) Making every management have experience for success case
3. Make Companies Familiar with QC Story	1) Decision of adequate education programme based on the investigation of management status 2) Education of how to collect data and fact-based information 3) Education of data analysis methods

	4) Education of root-cause isolation
	5) Planning of action items that are necessary for improvement
4. Take These Actions Physically	1) Implementation of improving actions
	2) Taking actions as scheduled
	3) Evaluation of results and retrospects
	4) Support such actions by CIPQ

2) References

To reduce in-process failures, and expedite from new product development to the mass-production phase.

a) Training in the following statistical methods is necessary:

(1) Population parameter and statistical measures
(2) Estimation and test
(3) Correlation analysis and regression analysis
(4) Analysis of variance
(5) Orthogonal array
(6) Control chart

b) Other methods

(1) Quality deployment, quality function deployment
(2) Management 7 tools
(3) Calculation of process capability index (Cp)
(4) Process design, control analysis, and assurance

3-2-1-6. Training Programme Recommended for Selected Six Faculty of FCAV in Japan

A) Based on the status identified through the pre-evaluation survey, the followings were recommended as the first-phase curriculum:

DAY	A.M.	P.M.	EVE.
1st week			
1	TQC concept	TQC implementing programme	
2	Management by policy(cross-functional)	Management by policy(daily routine-work)	Group Discussion
3	QA	Standardization	-ditto-
4	In-process control	Role of Top mgt. & facilitator	
5	QC circle concept	Q & A, GD presentation	
2nd week			
1	Plant visit		
2	Plant visit		
3	Plant visit		
4	Plant visit		
5	Q & A (contd.)	Final wrap-up meeting	

B) The JUSE project team recommend that the following items be covered during the 2nd and 3rd phases of the project:

(1) 5 S concept
(2) QC 7 Tools
(3) Quality Deployment
(4) Management 7 tools
(5) Design review
(6) Reliability and maintainability (FMEA & FTA)
(7) Product liability
(8) Advanced statistical method
(9) Maintenance concept

3-2-2. Activity 2: Two-Week TQC Training Programme for the Six FCAV Faculty conducted in Japan, from March 6 to 17, 1995 at JUSE Headquarters

3-2-2-1. General

A) TQC training programme

The programme consisted of mainly three parts: (1) Orientating TQC concepts and implementation procedures; (2) Roles and responsibilities of top management and facilitators; and (3) Briefing of methodology. (see Appendix 8)

B) Participants

The participants included:
6 faculty members of FCAV
1 staff member of Group Itautec - Philco
1 UNIDO staff member as observer
(see Appendix 9)

C) Interpretation

Two interpreters supported the programme. One interpreter have not had simultaneous translation experience and so verbatim method was obliged to proceed the whole programme.

D) Instructors

Instructors were assigned to individual courses according to their specialization. (see Appendix 10)

E) List of Appendixes

Appendix 8. Education programme and schedule
Appendix 9. Participants manifest
Appendix 10. Instructors manifest
Appendix 11. Material on "Group discussion procedures"
Appendix 12. Evaluation sheet by participants
Appendix 13. Text "General concept of TQC (I)"
Appendix 14. Text "General concept of TQC (II)"
Appendix 15. Text "QC story (PDCA)"
Appendix 16. Text "Policy management"
Appendix 17. Text "Daily work management"
Appendix 18. Text "Quality assurance"
Appendix 19. Text "Quality Function Deployment (QFD)"
Appendix 20. Text "Standardization"
Appendix 21. Text "Process Control"
Appendix 22. Text "Method for TQC"
Appendix 23. Text "Role of facilitator"
Appendix 24. Text "QC Circle"

3-2-2-2. Briefing of lectures

A) General concept of TQC (I) by Prof. Y. Washio
(see Appendix 13)

1) The origin of TQC, i.e. the concept proposed by Dr. W.E. Deming and Dr. J.M. Juran in 1950s, namely, the orientation of quality awarded business management controlled not by price, but by customer satisfaction.

2) Specific features of the TQC concepts in Japan, namely,

(1) Statistical method implementation
(2) Quality first
(3) QC Circle activity
(4) Quality Assurance from new product planning/development through after service
(5) Education and training, and
(6) Nation-wide activity for Quality Control

3) Historical perspective of Quality Control activity

(1) 1950-1955 --- Inspection oriented age
(2) 1956-1970 --- Concentrated on manufacturing process improvement
(3) 1971-1980 --- Emphasized on product planning and design improvement
(4) 1981-to date --- Identification of customer needs and new product development to meet with the above needs

B) General concept of TQC (General) (II) by I. Miyauchi
(see Appendix 14)

1) Break-through ways of thinking, including

(1) Market-in
(2) Next-down stream shop in customer
(3) Quality as the top priority
(4) Upper stream process control
(5) Fact and data appreciation
(6) Vital few, not trivial many
(7) Dispersion control
(8) Recurrent preventing action
(9) People-building
(10) Top management commitment understanding

2) TQC implementing actions, including

(1) Hoshin-Kanri (Management by policy)
- Cross-functional management
- Daily Routine-work Management
(2) Standardization in every shop
(3) Quality assurance in every phase and stage
(4) Quality assessment by the top management

3) Continuous improvement and sustenance by Plan-Do-Check-Act (QC Story)programme (see Appendix 15)

C) Policy management by Prof. Y. Tsuda (Refer to Appendix 16)

1) Weakness on "Management by objective" and its overcome programme is "Policy Management."

2) "Policy management" begins with strategy of top management commitment through mission, long and middle term policy and goal to annual policy deployment.

3) The explanation is shown by typical examples.

D) Daily work management by Prof. Y. Tsuda (see Appendix 17)

1) Structure of daily work management

2) Preparation of process flow-diagram for each operation at every workshop

3) Decision of check-points and managing points for customer satisfactions

E) Quality assurance by Prof. T. Yoshizawa (see Appendix 18)

1) Definition of quality assurance

2) Quality assurance in every product life cycle for customer oriented concepts.

3) Quality assurance for a new product is the first step

to be implemented.

4) Necessit of Quality Function Deployment programme (see to Appendix 19)

F) Standardization by Mr. I. Miyauchi (see Appendix 20)

1) Definition and kinds of standardization

2) Establishment of in-house standardization

3) ISO 9000 series

4) Types of technical-related standards

5) Production process standards

G) Process Control by Mr. H. Yoshikawa (Appendix 21)

1) Recommended method for improvement and sustenance on daily routine-work management stresses:

(1) Data collection
(2) Participation of every personnel
(3) Simpler method
(4) Root identification based on 3 Gen
(5) Establishment of corrective action against root-cause
(6) Verification by data for results

2) Case-study

H) Method of TQC by Mr. H. Yoshikawa (Appendix 22)

1) Explanation of QC story

2) Explanation of QC 7 Tools
(1) Pareto chart
(2) Fish-bone chart (cause and effect diagram)
(3) Tree diagram
(4) Relation diagram
(5) Matrix diagram

3) Case-study

I) Roles of facilitators by Mr. I. Miyauchi (Appendix 23)

1) Necessity of full understanding of TQC programme

2) Roles of facilitators

3) Desirable facilitators

4) Case-studies for consultation

J) QC Circle by Mr. I. Miyauchi (Appendix 24)

1) Human-behavior scientist concept for human-resource management

2) How to organize QC Circle

3) Roles and responsibilities of the top management

3-2-2-3. Group Discussion (Appendix 11)

A) Procedures of group discussion

1) Eight participants were organized into two groups to discuss the subjects concerning the following question. (see Appendix 11):

"What kinds of difficulties are anticipated in a TQC implementation programme in Brazilian Industries, under your situations?"

2) After the group discussion, the participants were requested to identify the top 2 difficulties among 5 critical things by matrix method and to establish corrective actions for the two highest priorities.

3) During the course of identifying the difficulties, it was recognized that the eight participants did not discuss their own weakness or problem for facilitating TQC implementation as facilitators.

Eventually, the participants realized that they should have taken their responsibility into consideration for their TQC implementation programme and so they should have seen themselves as facilitators in implementing the TQC programme. JUSE expert in charge of the group discussion should have reconfirmed it. As a result, the weakness and corrective actions that the participants picked up were not theirs but other companies'.

3-2-2-4. Plant visit

A) Kyosan Denki Co., Ltd.

1) Koga Plant in Ibaragi Pref. was visited.

2) Affiliated company of Nippon Denso Co.

3) Main product --- Electric automobile parts and components for fuel supply, fuel filtration, fuel control, ignition system, engine speed control etc.

4) The company's president, Mr. T. Kobata is a dynamic quality-oriented person. His self-devoting enthusiasm is deeply and profoundly rooted in not only management but every rank and level of personnel under his principles. He has

published four books about his 3-Gen Oriented Quality Control. The Gen means principle in Japanese. The three principles in his way of Quality Control is (1)people-promotion, (2)how to eliminate wastefulness, and (3) non-new machine but all modified from second-hands. He has his own philosophy on management, which is fully implemented.

5) The plant visited is well maintained under the 5S concepts and clean, effective, efficient workplace based on his 3-Gen concepts.

6) TQC is implemented under the Toyota quality concept and is fruitfully succeeded for survival and competitiveness dominancy. This is why not only Toyota, but other automobile companies such as Mitsubishi, Fuji Heavy Industry (Subaru), Daihatsu, Mazda appreciate Kyosan's product for their quality.

B) JATCO

1) JATCO (previously known as Japan Automatic Transmission Co.)

2) JATCO is a main supplier of automatic transmission assembly to Nissan Motors.

3) So far the products are machine-made. For most of the machinery processes, the company intends to realize non-man operation (full automation).

4) For that, TQC and TPM concepts are implemented for customer satisfaction with increased productivity attaining the world-level.

5) Yet, even though 5S programme is implemented, oil-soaked floor and oil mist in the operation are still observed.

C) Yamato Kogyo Co., Ltd.

1) This company is a supplier of pressed-components to Nissan Motors.

2) It is quite appreciated that the plant manager accompanied with us from the very beginning to the end of our visit with a highly cooperative attitude.

3) The company's presentation for their TQC was very concise to explain their status of Quality oriented customer satisfaction.

4) This company had 150 Brazilian employees until last December. But because of the economic recession, all of them have left the company and returned to their home country.

D) Mitsubishi Electric Building Techno-Service Co., Ltd. Education and Training Center

1) This center was build for customer education and Mitsubishi Service/Maintenance operator training for customer satisfaction.

2) Accordingly, various education models of building equipment such as elevator, air-conditioning, escalator etc. are equipped for that purpose.

3) Today's buildings are referred to as intelligent buildings. If Mitsubishi were concentrating to elevator alone, customers requirements could not be achieved. That's why diversification of business concept is necessary to conforming with today's needs.

4) Accordingly, they have changed their business focuses from just elevator maintenance (1954-1982) remote building monitoring service (1982-1985) and total building management (1985-1986) to intelligent building and, in future, to FM (Facility Management) business and information & communication business for customer quality assurance.

5) Their explanation referred mostly to quality assurance. TQC was not touched. Accordingly, information collection system and education and training programme were mostly covered.

3-2-2-5. Questions

During the general question-and-answer session, the followings were questioned:

A) How to start TQC after the completion of education.

B) How to deploy the top management policy and goal to the lower/middle management

3-2-2-6. Evaluation

A) Interpreter

Although from the very beginning of the preparatory work by JUSE, simultaneous interpretation was desired, it was done only partially. Yet, the whole programme was fully accomplished but not as expected and planned for each lecturer.

B) Evaluation by the participants

The Appendix 12 shows the evaluation by the participants.

3-2-2-7. Thinking-over

A) As aforementioned, the most important event for the participants, the group discussion was far from our intention. The failure could have been caused by the fact that the participants' understanding of TQC concepts was unexpectedly not sufficient. It means that our education programme was not effective enough.

B) TQC concept based on the "Empathy" concept which is "Blame yourself but not others", was not adopted by the participants.

C) It is, in fact, necessary for JUSE experts to conduct a follow-up programme until they could understand, implement, and teach TQC with their fully recognized awareness.

3-2-3. Activity 3: Three-Day Seminar in Brazil from September 12 to 14, 1995, conducted by Mr. I. Miyauchi (This activity way beyond the scope of TF/BRA/92/B10. Howerver, it was the responsibility of the project subcontractor of the project as covered by the complementary project, DP/BRA/92/004.)

3-2-3-1. Venue

The meeting room was at Flat Royal Ibirapuera Park Hotel, Rua Abillo Soares, 1251 - Paraiso/Sao Paulo, SP, Brazil.

3-2-3-2. Participants

According to FCAV, the organizer of the seminar, 55 participants were enrolled for the seminar, but 32 were physically attended for whole 3 days.

3-2-3-3. Seminar Programme (all topics were covered by Mr. Miyauchi)

A) Day 1 - September 12, 1995

08:30-09:00	The official opening address by the vice president of FCAV and the UNIDO project backstopping officer
09:00-15:30	TQC : TQC Definition Quality Definition, and the examples Control Definition Importance of Top Management Commitment TQC Implementation Programme TQC Concept * Market-In (Empathy) Concept * Next-Down shop is customer concept * Quality First concept * Upper Stream-Shop Control concept * Fact & Data Appreciation concept

* Vital Few concept
* Dispersion Control concept
* In-Process Control concept
* Respect Employees as Human-being concept
* Top Management Commitment Understanding concept

15:30-16:30 Q & A session for the above subjects
16:30-17:00 Mr. Melvin Cymbalista of FCAV high-lightened Mr. Miyauchi's presentation

B) Day 2 - September 13, 1995

09:00-10:00 Top Management Responsibility on TQC Implementation programme on
* Top Management Commitment Issuance for TQC
* Top Management Leadership
* Customer Focus
* Total Participation
* Systematic Analysis for Continuous Improvement

10:00-10:30 TQC Implementing Sequences
10:45-12:00 TQC Implementing Action
* Standardization in every office and shop
* Education and Training
* Management by Policy - Hoshin-Kanri
  Daily Routine-Management
* Quality Assurance
* Top Management Diagnosis
* Statistical Tool Utilization
* QC Circle Activities

14:00-15:00 Quality Assurance
15:00-15:30 Design Review Procedures
15:45-16:00 Product Liability
16:30-17:00 Q & A session for the above subjects
16:30-17:00 Mr. Melvin Cymbalista of FCAV high-lightened Mr. Miyauchi's presentation

C) Day-3 - September 15, 1995

09:00-10:30 Management by Policy, and Hoshin-Kanri (Cross-Functional Management), so-called Policy Deployment Procedures
10:45-11:00 QC Circle Activities
11:00-12:00 Daily Routine-Work Management
14:00-16:30 Mr. Cymbalista explained the role of Facilitators for TQC Implementation Programme
16:30-17:00 General Q & A
17:00-17:30 Closing session and Presenting Certificates to each participant by the FCAV President Pedro Luiz de Oliveira Costa Neto

3-2-3-4. Observation

A) Participants

Seemingly insufficient space of the reserved seminar room for 55 participants was the major concern in the preparatory meeting with FCAV staff on September 11. However, the actual number of the seminar participants turned to be 32 so that the space was actually large enough. The participants were very attentive and diligent for listening to and studying TQC concepts and implementation procedures.

B) Q & A session

Since the participants were given TQC concept orientation on the first day of the seminar, their questions referred mainly to how Japan had developed, implemented and sustained their TQC for such a long period of time with specific enthusiasm without any break-down or failure in its implementation, and what had been the motivation and trigger for such successful implementation. However, the primary TQC subjects were not brought up specifically in the participants' questions. The further follow-up programme will have to expedite TQC implementation schemes in various firms in order to identify their physical difficulties encountered.

3-2-3-5. Comments by Mr. Miyauchi

A) It was regrettable that FCAV faculty who participated in the two-week training programme at JUSE in Japan could not join the three-day seminar due to their engagement on other activities. (the only exception was Mr. Cymbalista). Although it was apparent that the three-day seminar in Brazil was a good opportunity to refresh their TQC learnings.

B) It was also felt regretful that they had not prepared any recording aids for the absent FCAV faculty who participated in the two-week training programme in Japan.

C) Although the seminar materials had been sent to FCAV in June 1995, they had not been translated them into Portuguese on time for the three-day seminar.

D) It is felt that for Brazilian industry personnel who are going to deal with TQC implementation, it is essential to receive continued training without long break if the risk of slipping out their enthusiasm toward TQC learnings is to be avoided.

3-2-3-6. Participants Survey Status

After the seminar the participants were surveyed in terms of their understanding and the current status of TQC in their companies. (full score is 10)

A) Are TQC concepts presented in the seminar important for enhancing the competitiveness of your organization?
- Yes's average: 9.48
- Respondents: 25

B) Can TQC concepts presented in the seminar be implemented in your organization in the short or medium term?
- Yes's average: 6.79
- Respondents: 24

C) Do you think that the courses planned to be offered in future by CIPQ will be helpful to implement TQC in your organization?
- Yes's average: 7.83
- Respondents: 24

3-2-3-7. Survey Evaluation

A) The seminar could be concluded as confirming with their interest and understanding of TQC concept.

B) However, they regard a TQC implementation programme as a long term project, not as a remedial action for effective immediate reactions.

C) Future CIPQ programme will be welcomed by the Brazilian industry personnel for their further study on TQC implementation. It seems necessary for CIPQ to receive continued support from JUSE in CIPQ's implementation and counseling schemes in several years to come.

3-2-3-8. Recommendation by Mr. Miyauchi

It is strongly recommended that CIPQ start the TQC implementation plan including Top Management and Middle Management education programme and Facilitators programme for Brazilian industry personnel as soon as possible.

3-3. CUSTOMIZED TEACHING MATERIAL FOR USE AT CIPQ

JUSE has already submitted the training materials for the two-week training course for FCAV faculty and for the three-day seminar for Brazilian industry personnel:

3-3-1. For the two-week training course for FCAV faculty

<Title of Text>	<Author>
- General concept of TQC (I)	Dr. Yasutoshi Washio
- General concept of TQC (II)	Mr. Ichiro Miyauchi
- QC Story (PDCA)	Mr. Ichiro Miyauchi
- Policy management	Dr. Yoshikazu Tsuda
- Daily work management	Dr. Yoshikazu Tsuda
- Quality assurance	Dr. Tadashi Yoshizawa
- Quality Function Deployment(QFD)	Dr. Tadashi Yoshizawa
- Standardization	Mr. Ichiro Miyauchi

- Process control Mr. Hideo Yoshikawa
- Method for TQC Mr. Hideo Yoshikawa
- Role of facilitators Mr. Ichiro Miyauchi
- QC Circle Mr. Ichiro Miyauchi

3-3-2. For the three-day seminar for Brazilian industry personnel

<Title of Text>	<Author>
- Total Quality Control (Synopsis)	Mr. Ichiro Miyauchi
- Quality Assurance	"
- Standardization*	"
- Product Liability	"
- Management by policy	"
- Role of Facilitators*	"

* The text is same as the one for the two-week training course's.

3-3-3. The subcontractor's Terms of Reference requires JUSE to make materials covering the following topics.**

- Design of Experiments
- Marketing for Continuous Improvement
- Accounting and Cost Management
- Measurement and Control in Continuous Process Industries
- Logistics
- Technology Development and Transfer

** With an approval of UNIDO, the subject of "Systems Implementation" was omitted because the subject is not a particular field of TQC.

These techniques are considered as more advanced TQC techniques.

To these individual subjects, the followings JUSE experts were assigned:

<Subject>	<Author>
- Design of Experiments	Dr. Yasutoshi Washio
- Marketing for Continuous Improvement	Dr. Noriaki Kanda
- Accounting and Cost Management	Mr. Takashi Kanatsu
- Measurement and Control in Continuous Process Industries	(see Note)
- Logistics	Mr. Ichiro Miyauchi
- Technology Development and Transfer	Dr. Hajime Karatsu

Note: The authors are Mr. Katsuyoshi Ishihara, Mr. Hiroyuki Takahashi, Dr. Ayatomo Kanno, Mr. Fumio Tanaka, Mr. Zenzaburo Katayama, Mr. Terutaka Urano, Mr. Katsuhiko Tsunoda, Mr. Yoshizo Hasegawa, Mr. Kaoru Shimoyamada, Mr. Shigeru Takagi, Mr. Yoshihisa Masuyama, and Mr. Koichi Oba

The materials to be prepared by Dr. Washio on Design of Experiments, by Mr. Kanatsu on Accounting and Cost Management, and by Dr. Karatsu on Technology Development and Transfer were extracted from their published books in Japanese and were translated.

The material prepared by Dr. Kanda originated from his articles on TQM and Marketing. The material on Measurement and Control in Continuous Process Industries originated from the articles on Process Control in JUSE magazine.

For the translation to Portuguese, all Japanese-written materials were submitted to FCAV. In addition, the English versions of these materials were also provided to FCAV.

4. TERMINAL SECTION

It is recognized that TQC concepts have not been fully understood yet by either Brazilian industry personnel or FCAV faculty. According to our experience, such slow process of learning is not unusual in the early stage of TQC learning. That is why continuous education programme is necessary to be employed for both FCAV faculty and Brazilian industry personnel under JUSE experts' support.

However, unless an effective TQC programme is implemented in every firm, failure reduction, and improvement of quality can not be fully achieved. In this connection, it is necessary for each firm to implement the following actions:

By middle management;
(1) Identify who are their customers
(2) What problem(s) is/are observed to annoy their customers
(3) Establish a priority for solutions of problems related to quality, cost, delivery, safety, morale, and environment.
(4) Then, solve such identified problem(s) one after another, and establish permanent-fixed-procedures for not recurring the problems again. While taking such corrective actions,
- Ensure if SOPs(Standards Operating Procedures) has been established in every operational process.
- If not, establish SOPs according to the criticism on each process for customer satisfactions.
- If yes, proceed the improvement until reaching and exceeding the bench marks formed at competitors' levels.

By top management; Establishing their business goals on quality, cost, delivery, safety, morale, and environment for customer satisfactions and improvement in competitiveness and deploy them to each responsible middle management.

At this stage, it can be said that the TQC concept is fully implemented company-wide for survival and company prosperity with every employee's participation.

For further development of the TQC programme, it is necessary to establish a five year programme such as the one shown in the attached table.

FIVE-YEAR PROGRAM (AN EXAMPLE)

Program \ Year		1996 (Apr / Oct)	1997 (Apr / Oct)	1998 (Apr / Oct)	1999 (Apr / Oct)	2000 (Apr / Oct)
in JAPAN at JUSE	Top/Mgt	2wks	2wks	2wks	2wks	2wks
	FCAV FACILITATORS	2wks 2wks	2wks 2wks	2wks		
	CO FACILITATORS Mid/Mgt	2wks May, 2wks Dec	2wks May, 2wks Dec	2wks May, 2wks Dec	2wks May, 2wks Dec	2wks, 2wks Dec
	CO&FCAV QCC Facilitators	2wks Kuala Lumpor	2wks Beijin	2wks Golombo	2wks Manila	2wks Tokyo
in Brazil by FCAV	Top/Mgt	1wk Jan, 1wk June	1wk Apr	1wk Apr	1wk Apr	1wk Apr
	Middle/Mgt	2wks Jan, 2wks July, 2wks Sept	2wks Jan, 2wks May, 2wks Sept	2wks Jan, 2wks May, 2wks Sept	2wks Jan, 2wks May, 2wks Sept	2wks Jan, 2wks June, 2wks Oct
	Facilitators	2wks Feb, 2wks July	2wks Feb, 2wks July	2wks Feb, 2wks July	2wks Feb, 2wks July	2wks Mar, 2wks July
in Brazil by JUSE	Education Support	Jan June, Mar Sept	Jan June, Mar Sept	Jan June, Mar Sept	Jan June, Mar Sept	Feb June, Mar Oct
	Consultancy	Ditto				

* wks=weeks

NEC DO BRASIL S/A
Rodovia Presidente Dutra, km 218
07210-902 Guarulhos, SP
Fone: 945-7013
Fax: 945-7097
Contato: Sr. José Geraldo de Melo

30/09/94 (6a.FEIRA)
DAS 09H00 ÀS 16H00

PHILIPS DO BRASIL LTDA
Rua Conde de Sarzedas, 55 - Centro
09400-970 Ribeirão Pires, SP
Fone: 459-8214
Fax: 459-8282
Contato: Sr. José Eduardo Leite

04/10/94 (3a.FEIRA)
DAS 08h30 ÀS 12H00

X HOECHST DO BRASIL
QUÍMICA E FARMACÊUTICA S/A
Av. dos Autonomistas, 4900
06194-060 Osasco, SP
Fone: 705-8700
Fax: 705-8858
Contato: Sr. Mitsuhisa Shoji

04/10/94 (3a.FEIRA)
DAS 14H00 ÀS 17H30

TOKO DO BRASIL
INDÚSTRIA E COMÉRCIO LTDA.
Rua José Mari, 80
06754-908 Taboão da Serra, SP
Fone: 491-5500
Fax: 491-2639
Contato: Sr. Alfredo P. Ferreira
Chefe do Controle de Qualidade

05/10/94 (4a.FEIRA)
DAS 08H30 ÀS 12H00

ARNO S/A
Av. Arno, 146
03108-900 São Paulo, SP
Fone: 915-7766
FAX: 274-8318
Contato: Eng. Walter Marcio Cunha

05/10/94 (4a.FEIRA)
DAS 14H00 ÀS 17H30

TINTAS CORAL S/A
Av. dos Estados, 4826 - Utinga
09220 Santo André, SP
Fone: 446-6433
Fax: 446-6045
Contato: Eng. José Abílio dos Santos

06/10/94 (5a.FEIRA)
DAS 09h00 ÀS 17H00

MC/mms
23/09/94

FUNDAÇÃO CARLOS ALBERTO VANZOLINI

PROGRAMAÇÃO DAS VISITAS ÀS EMPRESAS
PELOS SRS. ICHIRO MIYAUCHI E H. YOSHIKAWA (JUSE)

EMPRESAS	DATA DA VISITA
ITAUTEC INFORMÁTICA S/A Rua Bela Cintra, 1149 - 13. andar 01415 São Paulo, SP Fone: 64-5335 Fax: 881-5783 Contato: Sr. Robson Barcellos Gerente da Qualidade	**26/09/94 (2a.FEIRA) DAS 14H00 ÀS 17H30**
SCHLUMBERGER INDÚSTRIAS Rodovia Campinas Mogi-Mirim, km 121 13088-061 Campinas Fone: (0192) 57-1300 Fax: (0192) 57-1344	**27/09/94 (3a.FEIRA) DAS 8H30 ÀS 12H00**
RIMA IMPRESSORAS S/A Av. Prof. Francisco Morato, 4293 05521-200 Vila Sonia, SP Fone: 842-5842 Fax: 843-3753 Contato: Engo. Luiz Natal Rossi	**27/09/94 (3a.FEIRA) DAS 14H00 ÀS 17H00**
TELEMECANIQUE S/A Rua Carmo do Rio Verde, 218 04729 São Paulo, SP Fone: 541-8299 Fax: 523-7814 Contato: Sr. Hugo José Lemos da Silva Gerente/Depto. Central da Qualidade	**28/09/94 (4a.FEIRA) DAS 08H30 ÀS 12H00**
QUIMBRASIL QUÍMICA INDUSTRIAL BRASILEIRA Av. Maria Coelho Aguiar, 215 Bloco A - 3.andar Centro Empresarial 05805-000 São Paulo, SP Fone: 545-3015 Fax: 545-3185	**29/09/94 (5a.FEIRA) DAS 10H00 ÀS 17H00**

Appendix 2.

TQC CONCEPT
AWARING STATUS
SURVEY
CHECK SHEET

1. For Top Management

A) Issue his firm commitment for survival and competitivity under company prosperity concept by written form.

B) Issue his philosophy for customer satisfaction and quality oriented management, that is under TQC concept.

C) Establish business horizon and vision.

D) Establish mission statement, strategy and tactics for achieve ment of the aboves.

E) Establish a system for long,medium,and annual business plan and objectives.

F) Establish organizations for such achievement.

G) Issue such plan & objectives by long,medium,and annual base.

H) Reissue managing philosophy based on world/international status or trend changes when confronting such needs.

I) Establish prioritized vital-few objectives for business man-agement planning.

J) Disseminate policy & objective under quantifies & understand able expression to every employee.

K) Establish a procedures for policy and objectives achievement.

L) Verify such status weekly or monthly,and annually.

M) Identify critical problem by periodic diagnosis at workshop.

N) Improve mutual communication between top and subordinates.

O) Feed-back previous-year's problem/difficulty into next year planning and objectives for solution.

P) Continuously persuade every management to achieve objectives deployed.

Q) Achieve objectives as planned.

R) Recommend challenging & improving levels for middle-management goal setting on daily routine-work management.

S) Recognize and implement the importance of his personal involvement on business management.

T) Recognize necessity for adequate awarding system establishment for motivation and challenging employees.

U) Evaluate if the objectives established are over or under-decision based on, while comparing with competitors,
(1) Profitability
(2) Productivity
(3) Competitivity
(4) Growth Rate
(5) Risk-Management
(6) Customer Satisfaction
(a) Quality
(b) Cost/Price
(c) Delivery
(d) Safety
(e) Environment Protection
(f) Human Resource Development

V) Establish internal and external customer (including end-users) information collection system with high confidence level.

W) Evaluate such information for measuring and establishing corrective actions.

X) Display leadership for customer claim/complain handling.

Y) Educate and train employees for TQC concept, especially for involvement and participation;
(1) Market-In Concept
(2) Internal Customer Concept
(3) Quality First Concept
(4) Fact & Date Appreciation Concept
(5) Vital-Few Concept
(6) dispersion Control Concept
(7) Inprocess Control, Not Result oriented, Concept
(8) Recurrent Prevention Concept
(9) Human-Oriented Behavior Concept
(10) Employees full Participation Concept
(11) Upper Stream-Control Concept

Z) Install QC circle activity

2. SENIOR AND MIDDLE MANAGEMENT

A) Understand the system for business management policy and objective establishing program.

B) Understand the top management business philosophy under survival and predominant competitivity accomplishment.

C) Understand the TOP management quality commitment based on customer full satisfaction,under TQC concept (refer to Top Management Paragraph(Y))

D) Establish own's philosophy and commitment (vision and strategy) to conform with the top management's.

~~F) Establish own's plan and objectives to perform the top management's.~~

E) Identify and recognize own's role,responsibility and participation scopes.

F) Establish own's plan and objectives to perform the top management's.

G) Disseminate own's customer satisfaction program under quality assurance concept to every subordinates.

H) Establish such quality assurance procedures as standard.

I) Educate and train such standard continuously.

J) Have subordinates recognize their own responsibilities in daily routine-work.

k) Encourage subordinates to understand QC story procedures (Plan-Do-Check-Work) for their daily routine-work improvement or corrective action.

L) Establish close and compact relationship between horizontal organizations (same level).

M) Establish own's consistent and compatible plan and objectives with not only top management but with horizontal level management.

N) Improve mutual communications between same level horizontal organizations.

O) Can use QC story (Plan-Do-Check-Act) method.

P) Can use QC 7 tools.

atmosphere.

O) Build-up free conversation atmosphere.

P) Foster human-touched and -appreciation concept.

Q) Participate in QC circle with own's decision.

R) Participate with suggestion proposal program.

ASSESSMENT SHEET

[illegible] Sept '94 ITAUTEC (São Paulo)

ITEM No.	EVALUATION						REMARKS
	0	1	2	3	4	5	
1 A)				○			1986年発行(計画的)重要はない
B)		QAあり.		○			
C)	○ なし						
D)	○						
E)		INDUSTRIAL ○ PLANNING あり					1994/2月より 社員への[illegible]はなく、部署では IE, [illegible]を活用[illegible]
F)		○					
G)		○					
H)	○						BENCH MARK はなく、[illegible]のみ
I)	○						
J)	○						SUPERVISOR [illegible] NOTIFY [illegible] DEPENDENT[illegible]
K)	○						
L)		○					MONTHLY のみ
M)	○						
N)		○					
O)		○					
P)		○					
Q)				○			
R)	○						
S)		○					
T)	○						
U(1)	○						
U(2)				○			
U(3)	○						
U(4)	○						
U(5)	○						
U(6a)				○			

U(6b)				○			
U(6c)				○			
U(6d)	○						
U(6e)	○						
U(6f)	○						
V				○			
X	○						
Y(1)	○						
Y(2)	○						中がつてない
Y(3)	○						
Y(4)	○						
Y(5)	○						
Y(6)	○						
Y(7)	○						
Y(8)	○						
Y(9)	○						
Y(10)	○						
Y(11)	○						
Z	○						
W		○					
2 A)						○	
B)						○	1991年発行したものあり
C)				○			SPECにMEETすることで、[illegible]の
D)	○						
E)	○						部下の作業(自分のものない)
F)						○	
G)	○						明確に使用していないが、記憶に残っている
H)						○	
I)						○	
J)					○		のREQUESTの度にくり返し

K)	○						・[illegible]
L)						○	
M)						○	
N)						○	
O)	○						・[illegible]
P)						○	
Q)		○					[illegible]
R)		○					〃
S)						○	
T)					○		
U)						○	Top [illegible]
V)					○		
W)				○			[illegible]

3 A) STAFF						○	
SUPERVISOR							
OPERATOR							
B) STAFF						○	日本にNTGと契約される
SUPERVISOR							
OPERATOR							
C) STAFF	○						
SUPERVISOR							
OPERATOR							
D) STAFF						○	
SUPERVISOR							
OPERATOR							
E) STAFF	○						
SUPERVISOR							
OPERATOR							
F) STAFF						○	
SUPERVISOR							
OPERATOR							
G) STAFF						○	
SUPERVISOR							
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H) STAFF						○	
SUPERVISOR							
OPERATOR							
I) STAFF						○	
SPERVISOR							
OPERATOR							
J) STAFF						○	
SUPERVISOR							
OPERATOR							

K) STAFF	○	
SUPERVISOR		
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L) STAFF	○	
SUPERVISOR		
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M) STAFF	○	
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N) STAFF	○	
SUPERVISOR		
OPERATOR		
O) STAFF	○	
SUPERVISOR		
OPERATOR		
P) STAFF	○	
SUPERVISOR		
OPERATOR		
Q) STAFF		Not applicable
SUPERVISOR		
OPERATOR		
R) STAFF	○	
SPERVISOR		
OPERATOR		

ASSESSMENT SHEET

27 Sept '94 (AM) — SCHLUMBERGER INDUSTRIE

ITEM No.	EVALUATION 1	2	3	4	5	REMARKS
I A)			O			CREEDは全部ではまっている 工場長 1990年発行
B)					O	
C)				O		本社流れ。BENCH MARK的発想ない
D)					O	
E)					O	
F)					O	
G)					O	
H)					O	新製品を開発 (旧型はMKT NEEDに合わない)
I)			O			明らかでない
J)					O	CATCH BALLによる決定
K)					O	CATCH BALLによる決定
L)					O	
M)				O		DELEGATE [illegible]
N)					O	
O)					O	
P)					O	
Q)				O		
R)			O			現場長 [illegible] 多い
S)				O		日常的なものはない (病[illegible]への[illegible])
T)				O		skill向上のみ
U(1)			O			[illegible] のみ
U(2)			O			
U(3)			O			
U(4)			O			
U(5)			O			
U(6a)			O			

U(6b)				O			
U(6c)				O			
U(6d)				O			
U(6e)				O			
U(6f)				O			
V						O	
X					O		DELEGATE [illegible]
Y(1)			O				
Y(2)			O				
Y(3)			O				
Y(4)			O				
Y(5)	O						
Y(6)			O				
Y(7)			O				
Y(8)			O				
Y(9)			O				
Y(10)			O				
Y(11)	O						
Z						O	
W	O						人事部と直接
2 A)						O	
B)						O	
C)						O	
D)	O						
E)				O			
F)	O						
G)	O						
H)						O	
I)						O	[illegible]/YKへ[illegible]
J)					O		[illegible]

K)	○						
L)					○		
M)					○		
N)					○		
O)	○						
P)					○		ACCで静ってる.
Q)				○			ACCで解ってるのみ
R)				○			VE, 見た時わかっている
S)						○	
T)						○	
U)						○	最適に近い状態まで定着している.
V)						○	
W)						○	

3 A) STAFF							
SUPERVISOR							
OPERATOR							
B) STAFF							
SUPERVISOR							
OPERATOR							
C) STAFF							
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Q) STAFF							
SUPERVISOR							
OPERATOR							
R) STAFF							
SPERVISOR							
OPERATOR							

ASSESSMENT SHEET

27 Sept '94 (PM) RIMA IMPRESSORAS (S.P.)

ITEM No.	EVALUATION						REMARKS
		1	2	3	4	5	
1 A)	○						TQCには上たCOMMITなし
B)				○			STRATEGY PLANに含まれる
C)				○			STRATEGY PLANに含まれる
D)						○	(ISO 9001も含めて) STRATEGY PLANを1993年末発行.
E)						○	
F)			○				利益計画(取締役会にて)
G)			○				利益計画のみ
H)						○	
I)						○	
J)	○						
K)	○						
L)						○	BIMONTHLY, WEEKLY FOLLOW-UP
M)	○						
N)	○						
O)	○						
P)	○						
Q)					○		−10%程度
R)	○						
S)		○					
T)	○						
U(1)					○		
U(2)					○		
U(3)					○		
U(4)					○		
U(5)	○						X
U(6a)			○				3.5% claim

U(6b)				○			
U(6c)			○				3~6日かかる(OEMの場合)
U(6d)	○						
U(6e)	○						
U(6f)	○						
V						○	
X	○						
Y(1)	○						
Y(2)							
Y(3)							
Y(4)							
Y(5)							
Y(6)							
Y(7)							
Y(8)							
Y(9)							
Y(10)							
Y(11)	○						
Z	○						
W	○						
2 A)						○	
B)						○	
C)						○	
D)	○						
E)						○	ISO 9001 Accredited Oct 96
F)			○				ONLY FOR PRODUCTION SCHEDULE
G)			○			○	ONLY FOR PRODUCTION SCHEDULE
H)						○	
I)						○	4 HR FOR OPR, 24 HR FOR MGR
J)							Visible Boardで SOPを掲示.

K)	○						
L)						○	
M)						○	
N)						○	
O)	○						
P)	○						
Q)	○						
R)	○						
S)					○		
T)				○			
U)					○		
V)				○			業務上のMTGのみ 一般的産業界での会話的MTGはない
W)		○					特別のものなし（休憩室の雑談）

3 A) STAFF	
SUPERVISOR	
OPERATOR	
B) STAFF	
SUPERVISOR	
OPERATOR	
C) STAFF	
SUPERVISOR	
OPERATOR	
D) STAFF	
SUPERVISOR	
OPERATOR	
E) STAFF	
SUPERVISOR	
OPERATOR	
F) STAFF	
SUPERVISOR	
OPERATOR	
G) STAFF	
SUPERVISOR	
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H) STAFF	
SUPERVISOR	
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I) STAFF	
SPERVISOR	
OPERATOR	
J) STAFF	
SUPERVISOR	
OPERATOR	

K) STAFF							
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Q) STAFF							
SUPERVISOR							
OPERATOR							
R) STAFF							
SPERVISOR							
OPERATOR							

28 Sept (Wed) (AM) ASSESSMENT SHEET

9月28日(水)(AM).

TELEMECANIQUE

ITEM No.	EVALUATION	1	2	3	4	5	REMARKS
1 A)	○						
B)						○	9/9/90 MR. P. L. BECKER issue
C)	○						
D)				○			
E)				○			
F)				○			
G)				○			
H)				○			
I)		○					
J)	○						
K)	○						
L)				○			
M)	○						
N)		○					
O)		○					
P)		○					
Q)				○			
R)		○					
S)	○						
T)	○						
U(1)		○					
U(2)		○					
U(3)	○						
U(4)	○						
U(5)	○						
U(6a)		○					

U(6b)	○						
U(6c)		○					
U(6d)	○						
U(6e)		○					
U(6f)	○						
V						○	
X		○					
Y(1)	○						
Y(2)	○						
Y(3)	○						
Y(4)	○						
Y(5)	○						
Y(6)	○						
Y(7)	○						
Y(8)	○						
Y(9)	○						
Y(10)	○						
Y(11)	○						
Z	○						
W	○						
2 A)						○	
B)	○						
C)						○	
D)						○	
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F)	○						
G)	○						
H)						○	
I)		○					
J)				○			

K)	○	
L)		○
M)		○
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O)	○	
P)		○
Q)	○	
R)	○	
S)		○
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U)	○	
V)	○	
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3 A) STAFF								
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Q) STAFF							
SUPERVISOR							
OPERATOR							
R) STAFF							
SPERVISOR							
OPERATOR							

ASSESSMENT SHEET

29 SEPT '94 (TH) SERRANA, QUIMBRASIL

ITEM No.	EVALUATION 1	2	3	4	5	REMARKS
I A)	○					TQM導入中とのこと。
B)	○					
C)					○	
D)					○	ISO9001で要求されて作ったらしい
E)	○					年度計画のみ
F)	○					無い(@ OFFICE と)
G)			○			
H)	○					
I)	○					
J)			○			経理的なもののみ
K)	○					
L)				○		MONTHLY
M)	○					
N)	○					経理的なもの・・・
O)	○					〃
P)	○					〃
Q)			○			若干(一)気味(生産量のみ)
R)	○					
S)	○					
T)	○					
U(1)					○	
U(2)					○	
U(3)			○			経理的なもののみ
U(4)					○	
U(5)	○					
U(6a)			○			CLAIM 2件のみ

B

U(6b)		○					GOESS [illegible]
U(6c)						○	
U(6d)						○	
U(6e)						○	
U(6f)	○						
V	○						
X	○						
Y(1)	○						
Y(2)							
Y(3)							
Y(4)							
Y(5)							
Y(6)							
Y(7)							
Y(8)							
Y(9)							
Y(10)							
Y(11)	○						
Z	○						
W	○						
2 A)							
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3 A) STAFF							
SUPERVISOR							
OPERATOR							
B) STAFF							
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SUPERVISOR							
OPERATOR							
R) STAFF							
SPERVISOR							
OPERATOR							

30 Sept. (Fri)
9月30日(金)

ASSESSMENT SHEET

NEC. Brasil

ITEM No.	EVALUATION 1	2	3	4	5	REMARKS
1 A)					○	
B)					○	日本 Levelに合致
C)					○	
D)			○			
E)					○	
F)			○			中央TQC officeが弱い
G)					○	
H)					○	
I)					○	
J)					○	
K)					○	
L)					○	
M)					○	monthlyに実施
N)			○			表彰はない
O)					○	
P)					○	
Q)				○		
R)					○	
S)			○			自己診断制度を採用
T)				○		検討中
U(1)					○	
U(2)					○	
U(3)					○	
U(4)					○	
U(5)					○	
U(6a)					○	

U(6b)						○	
U(6c)						○	
U(6d)						○	
U(6e)						○	
U(6f)						○	
V					○		
X						○	
Y(1)						○	
Y(2)						○	
Y(3)						○	
Y(4)						○	
Y(5)						○	
Y(6)						○	
Y(7)						○	
Y(8)						○	
Y(9)						○	
Y(10)						○	
Y(11)						○	
Z					○		
W						○	
2 A)						○	
B)						○	
C)						○	
D)						○	
E)						○	FUNCTION ACTIVITY ノ取扱ヲ規定シ人事ヨリ発行
F)						○	
G)						○	
H)						○	
I)						○	
J)				○			

K)						○	
L)						○	暖房・冷房は いつも 節約している。
M)						○	
N)						○	
O)						○	
P)				○			NOT APPLICABLE
Q)						○	
R)				○			NOT APPLICABLE
S)						○	
T)					○		SOMETIMES NOT
U)						○	
V)				○			
W)						○	

3 A) STAFF						○	5 YEAR PLANNING
SUPERVISOR							
OPERATOR							
B) STAFF						○	
SUPERVISOR							
OPERATOR							
C) STAFF						○	
SUPERVISOR							
OPERATOR							
D) STAFF						○	
SUPERVISOR							
OPERATOR							
E) STAFF						○	
SUPERVISOR							
OPERATOR							
F) STAFF						○	
SUPERVISOR							
OPERATOR							
G) STAFF						○	
SUPERVISOR							
OPERATOR							
H) STAFF						○	
SUPERVISOR							
OPERATOR							
I) STAFF						○	
SPERVISOR							
OPERATOR							
J) STAFF						○	
SUPERVISOR							
OPERATOR							

K) STAFF						○	
SUPERVISOR							
OPERATOR							
L) STAFF						○	
SUPERVISOR							
OPERATOR							
M) STAFF						○	
SUPERVISOR							
OPERATOR							
N) STAFF						○	
SUPERVISOR							
OPERATOR							
O) STAFF						○	
SUPERVISOR							
OPERATOR							
P) STAFF						○	
SUPERVISOR							
OPERATOR							
Q) STAFF						○	
SUPERVISOR							
OPERATOR							
R) STAFF						○	
SPERVISOR							
OPERATOR							

ASSESSMENT SHEET

4 Oct '94 PHILIP COMPONENT

ITEM No.	EVALUATION 1	2	3	4	5	REMARKS
1 A)					O	
B)					O	
C)				O		
D)					O	
E)					O	HAVE 4 YEARS STRATEGY
F)				O		
G)					O	
H)					O	BY ORDER OF HQ OFFICE
I)			O			
J)					O	
K)					O	
L)					O	MONTHLY EVALUATE
M)			O			
N)					O	
O)					O	
P)			O			
Q)				O		
R)			O			ORDER JOIN BY TOP
S)			O			HAVE JOIN WORKING-GROUP
T)					O	
U(1)					O	
U(2)					O	
U(3)					O	
U(4)					O	
U(5)					O	
U(6a)					O	

U(6b)						○	
U(6c)						○	
U(6d)						○	
U(6e)						○	
U(6f)				○			
V						○	
X						○	
Y(1)					○		
Y(2)						○	
Y(3)				○			
Y(4)				○			
Y(5)				○			
Y(6)						○	
Y(7)						○	
Y(8)				○			
Y(9)				○			
Y(10)						○	
Y(11)						○	
Z						○	AS WORKING-GROUP
W/						○	
2 A)							
B)							
C)							
D)							
E)							
F)							
G)							
H)							
I)							
J)							

K)							
L)							
M)							
N)							
O)							
P)							
Q)							
R)							
S)							
T)							
U)							
V)							
W)							

3 A) STAFF							
SUPERVISOR							
OPERATOR							
B) STAFF							
SUPERVISOR							
OPERATOR							
C) STAFF							
SUPERVISOR							
OPERATOR							
D) STAFF							
SUPERVISOR							
OPERATOR							
E) STAFF							
SUPERVISOR							
OPERATOR							
F) STAFF							
SUPERVISOR							
OPERATOR							
G) STAFF							
SUPERVISOR							
OPERATOR							
H) STAFF							
SUPERVISOR							
OPERATOR							
I) STAFF							
SPERVISOR							
OPERATOR							
J) STAFF							
SUPERVISOR							
OPERATOR							

K) STAFF							
SUPERVISOR							
OPERATOR							
L) STAFF							
SUPERVISOR							
OPERATOR							
M) STAFF							
SUPERVISOR							
OPERATOR							
N) STAFF							
SUPERVISOR							
OPERATOR							
O) STAFF							
SUPERVISOR							
OPERATOR							
P) STAFF							
SUPERVISOR							
OPERATOR							
Q) STAFF							
SUPERVISOR							
OPERATOR							
R) STAFF							
SPERVISOR							
OPERATOR							

ASSESSMENT SHEET

5 Oct '94 (AM) Toko

ITEM No.	EVALUATION 1	2	3	4	5	REMARKS
I A)					○	
B)					○	
C)					○	
D)					○	
E)					○	
F)				○		
G)					○	
H)					○	
I)					○	
J)					○	
K)					○	
L)					○	
M)					○	
N)					○	
O)					○	
P)					○	
Q)				○		
R)					○	
S)			○			
T)				○		
U(1)					○	
U(2)					○	
U(3)					○	
U(4)					○	
U(5)			○			
U(6a)					○	

U(6b)						○	
U(6c)						○	
U(6d)						○	
U(6e)						○	
U(6f)						○	
V						○	
X						○	
Y(1)						○	
Y(2)						○	
Y(3)						○	
Y(4)				○			
Y(5)				○			
Y(6)						○	
Y(7)						○	
Y(8)						○	
Y(9)				○			
Y(10)				○			
Y(11)						○	
Z						○	
W						○	
2 A)							
B)							
C)							
D)							
E)							
F)							
G)							
H)							
I)							
J)							

K)								
L)								
M)								
N)								
O)								
P)								
Q)								
R)								
S)								
T)								
U)								
V)								
W)								

3 A) STAFF							
SUPERVISOR							
OPERATOR							
B) STAFF							
SUPERVISOR							
OPERATOR							
C) STAFF							
SUPERVISOR							
OPERATOR							
D) STAFF							
SUPERVISOR							
OPERATOR							
E) STAFF							
SUPERVISOR							
OPERATOR							
F) STAFF							
SUPERVISOR							
OPERATOR							
G) STAFF							
SUPERVISOR							
OPERATOR							
H) STAFF							
SUPERVISOR							
OPERATOR							
I) STAFF							
SPERVISOR							
OPERATOR							
J) STAFF							
SUPERVISOR							
OPERATOR							

K) STAFF							
SUPERVISOR							
OPERATOR							
L) STAFF							
SUPERVISOR							
OPERATOR							
M) STAFF							
SUPERVISOR							
OPERATOR							
N) STAFF							
SUPERVISOR							
OPERATOR							
O) STAFF							
SUPERVISOR							
OPERATOR							
P) STAFF							
SUPERVISOR							
OPERATOR							
Q) STAFF							
SUPERVISOR							
OPERATOR							
R) STAFF							
SPERVISOR							
OPERATOR							

ASSESSMENT SHEET

5 Oct '94

ARNO S.A.

ITEM No.	EVALUATION 1	2	3	4	5	REMARKS
1 A)	○					NOT YET.
B)					○	ISSUED IN 1993 BY THE PRESIDENT.
C)	○					
D)	○					
E)				○		
F)	○					
G)				○		
H)				○		
I)					○	
J)					○	
K)				○		
L)					○	OPN IS EVERY 15 DAYS
M)					○	
N)					○	
O)					○	
P)					○	
Q)				○		
R)			○			
S)					○	
T)			○			
U(1)					○	
U(2)					○	
U(3)					○	
U(4)					○	
U(5)	○					
U(6a)					○	

U(6b)						○	
U(6c)						○	
U(6d)						○	
U(6e)						○	
U(6f)						○	
V						○	
X						○	
Y(1)				○			
Y(2)						○	
Y(3)						○	
Y(4)						○	
Y(5)						○	
Y(6)					○		
Y(7)					○		
Y(8)					○		
Y(9)				○			
Y(10)				○			
Y(11)	○						
Z	○						
W						○	
2 A)							
B)							
C)							
D)							
E)							
F)							
G)							
H)							
I)							
J)							

K)							
L)							
M)							
N)							
O)							
P)							
Q)							
R)							
S)							
T)							
U)							
V)							
W)							

3 A) STAFF							
SUPERVISOR							
OPERATOR							
B) STAFF							
SUPERVISOR							
OPERATOR							
C) STAFF							
SUPERVISOR							
OPERATOR							
D) STAFF							
SUPERVISOR							
OPERATOR							
E) STAFF							
SUPERVISOR							
OPERATOR							
F) STAFF							
SUPERVISOR							
OPERATOR							
G) STAFF							
SUPERVISOR							
OPERATOR							
H) STAFF							
SUPERVISOR							
OPERATOR							
I) STAFF							
SPERVISOR							
OPERATOR							
J) STAFF							
SUPERVISOR							
OPERATOR							

K) STAFF							
SUPERVISOR							
OPERATOR							
L) STAFF							
SUPERVISOR							
OPERATOR							
M) STAFF							
SUPERVISOR							
OPERATOR							
N) STAFF							
SUPERVISOR							
OPERATOR							
O) STAFF							
SUPERVISOR							
OPERATOR							
P) STAFF							
SUPERVISOR							
OPERATOR							
Q) STAFF							
SUPERVISOR							
OPERATOR							
R) STAFF							
SPERVISOR							
OPERATOR							

ASSESSMENT SHEET

6 Oct. '94 Tintas CORAL T

ITEM No.	EVALUATION						REMARKS
		1	2	3	4	5	
1 A)	○						
B)						○	
C)		○					
D)						○	
E)						○	
F)						○	
G)						○	
H)						○	
I)		○					
J)		○					
K)						○	
L)						○	MONTHLY BASIS.
M)		○					
N)	○						
O)			○			○	
P)			○				
Q)						○	
R)			○				
S)			○				
T)	○						
U(1)						○	
U(2)						○	
U(3)						○	
U(4)						○	
U(5)		○					
U(6a)				○			

U(6b)						O	
U(6c)						O	
U(6d)						O	
U(6e)						O	
U(6f)				O			
V						O	BY CONSULTANT
X				O			
Y(1)						O	
Y(2)						O	
Y(3)						O	
Y(4)						O	
Y(5)	O						
Y(6)				O			
Y(7)				O			
Y(8)						O	
Y(9)						O	
Y(10)						O	
Y(11)	O						
Z	O						
W						O	
2 A)						O	INTERVIEWED with QC MGR
B)						O	
C)						O	
D)	O						
E)		O					
F)		O					
G)		O					
H)		O					
I)						O	NOT APPROVED BY PROCESS ENGINEERING CERTIFIED ISO 9002
J)					O		NOT PERIODICALLY

K)	○						
L)	○						
M)				○			
N)				○			
O)				○			
P)	○						
Q)	○						
R)				○			
S)	○						
T)				○			
U)						○	
V)						○	
W)	○						PLANNING
X)	○						PLANNING

3 A) STAFF							
SUPERVISOR							
OPERATOR							
B) STAFF							
SUPERVISOR							
OPERATOR							
C) STAFF							
SUPERVISOR							
OPERATOR							
D) STAFF							
SUPERVISOR							
OPERATOR							
E) STAFF							
SUPERVISOR							
OPERATOR							
F) STAFF							
SUPERVISOR							
OPERATOR							
G) STAFF							
SUPERVISOR							
OPERATOR							
H) STAFF							
SUPERVISOR							
OPERATOR							
I) STAFF							
SPERVISOR							
OPERATOR							
J) STAFF							
SUPERVISOR							
OPERATOR							

K) STAFF							
SUPERVISOR							
OPERATOR							
L) STAFF							
SUPERVISOR							
OPERATOR							
M) STAFF							
SUPERVISOR							
OPERATOR							
N) STAFF							
SUPERVISOR							
OPERATOR							
O) STAFF							
SUPERVISOR							
OPERATOR							
P) STAFF							
SUPERVISOR							
OPERATOR							
Q) STAFF							
SUPERVISOR							
OPERATOR							
R) STAFF							
SPERVISOR							
OPERATOR							

Appendix 4.

ASSESSMENT SUMMARY SHEET

COMPANY / CRITERIA	A	B	C	D	E	F	G	H
PARA 1 TOTAL	220	64	54	50	169	32	204	215
PARA 2 TOTAL	110	N/A	25	72	78	69	N/A	N/A
PARA 3 TOTAL	STAFF 90	N/A	N/A	N/A	N/A	STAFF 80	N/A	N/A
PARA 4 TOTAL								
1 A)	5	0	0	0	3	3	5	5
B)	5	0	5	3	5	3	5	5
C)	5	5	0	3	4	0	4	5
D)	5	5	3	3	3	0	5	5
E)	5	1	3	5	5	1	5	5
F)	3	1	3	2	5	1	4	3
G)	5	3	3	2	5	1	5	5
H)	5	1	3	5	5	0	5	5
I)	5	1	1	5	3	0	3	5
J)	5	3	3	0	5	0	5	5
K)	5	1	1	0	5	0	5	5
L)	5	4	3	5	5	1	5	5
M)	5	0	0	0	4	0	3	5
N)	3	1	1	0	1	1	5	5
O)	5	1	1	0	5	1	5	5
P)	5	1	1	0	5	1	3	5
Q)	4	3	3	4	4	3	4	4

R)	5	1	1	0	3	0	3	5
S)	3	0	0	1	4	1	3	3
T)	4	0	0	0	4	0	5	4
U(1)	5	5	1	0	3	3	5	5
U(2)	5	5	1	0	3	0	5	5
U(3)	5	3	0	0	3	0	5	5
U(4)	5	5	0	0	3	0	5	5
U(5)	5	0	0	0	3	0	3	3
U(6a)	5	3	1	2	3	3	5	5
U(6b)	5	1	0	3	3	3	5	5
U(6c)	5	5	1	2	3	3	5	5
U(6d)	5	5	0	0	3	0	5	5
U(6e)	5	5	1	0	3	0	5	5
U(6f)	5	0	0	0	3	0	3	5
V	4	0	5	5	5	3	5	5
X	5	0	1	0	4	0	5	5
Y(1)	5	0	0	0	2	0	4	5
Y(2)	5	0	0	0	2	0	5	5
Y(3)	5	0	0	0	2	0	3	5
Y(4)	5	0	0	0	2	0	3	4
Y(5)	5	0	0	0	0	0	3	4
Y(6)	5	0	0	0	2	0	5	5
Y(7)	5	0	0	0	2	0	5	5
Y(8)	5	0	0	0	2	0	3	5
Y(9)	5	0	0	0	2	0	3	5
Y(10)	5	0	0	0	2	0	5	4
Y(11)	5	0	0	0	0	0	5	4
Z	4	0	0	0	5	0	5	5
W	5	0	0	0	1	0	5	5

	A	B	C	D	E	F		
2 A)	5		5	5	5	5		
B)	5		0	5	5	5		
C)	5		5	5	5	3		
D)	5		0	0	0	0		
E)	5		0	5	3	0		
F)	5		0	2	0	0		
G)	5		0	2	0	0		
H)	5		5	5	5	5		
I)	5		1	5	5	5		
J)	5		3	4	3	3		
K)	5		0	0	0	0		
L)	5		1	5	4	5		
M)	5		1	5	4	5		
N)	5		1	5	4	5		
O)	5		1	0	0	0		
P)	3		1	0	4	5		
Q)	5		0	0	3	1		
R)	3		0	0	3	1		
S)	5		1	4	5	5		
T)	4		0	3	5	4		
U)	5		0	4	5	5		
V)	3		0	3	5	4		
W)	5		0	1	5	3		

3 A) STAFF	5					5			
SUPERVISOR									
OPERATOR									
B) STAFF	5					5			
SUPERVISOR									
OPERATOR									
C) STAFF	5					0			
SUPERVISOR									
OPERATOR									
D) STAFF	5					5			
SUPERVISOR									
OPERATOR									
E) STAFF	5					0			
SUPERVISOR									
OPERATOR									
F) STAFF	5					5			
SUPERVISOR									
OPERATOR									
G) STAFF	5					5			
SUPERVISOR									
OPERATOR									
H) STAFF	5					5			
SUPERVISOR									
OPERATOR									
I) STAFF	5					5			
SPERVISOR									
OPERATOR									
J) STAFF	5					5			
SUPERVISOR									
OPERATOR									

K) STAFF	5					5			
SUPERVISOR									
OPERATOR									
L) STAFF	5					5			
SUPERVISOR									
OPERATOR									
M) STAFF	5					5			
SUPERVISOR									
OPERATOR									
N) STAFF	5					5			
SUPERVISOR									
OPERATOR									
O) STAFF	5					5			
SUPERVISOR									
OPERATOR									
P) STAFF	5					5			
SUPERVISOR									
OPERATOR									
Q) STAFF	5					5			
SUPERVISOR									
OPERATOR									
R) STAFF	5					5			
SPERVISOR									
OPERATOR									

ASSESSMENT SUMMARY SHEET

COMPANY / CRITERIA	I	J						
PARA 1 TOTAL	178	157						
PARA 2 TOTAL	N/A	50						
PARA 3 TOTAL	N/A	N/A						
PARA 4 TOTAL	N/A	N/A						
1 A)	0	0						
B)	5	5						
C)	0	0						
D)	0	5						
E)	4	5						
F)	0	5						
G)	4	5						
H)	4	5						
I)	5	1						
J)	5	1						
K)	4	5						
L)	5	5						
M)	5	1						
N)	5	0						
O)	5	2						
P)	5	2						
Q)	4	5						

R)	3	2							
S)	5	2							
T)	3	0							
U(1)	5	5							
U(2)	5	5							
U(3)	5	5							
U(4)	5	5							
U(5)	1	1							
U(6a)	5	3							
U(6b)	5	5							
U(6c)	5	5							
U(6d)	5	5							
U(6e)	5	5							
U(6f)	5	3							
V	5	5							
X	5	3							
Y(1)	5	5							
Y(2)	5	5							
Y(3)	5	5							
Y(4)	5	5							
Y(5)	5	0							
Y(6)	4	3							
Y(7)	4	3							
Y(8)	4	5							
Y(9)	3	5							
Y(10)	3	5							
Y(11)	0	0							
Z	0	0							
W	5	5							

2 A)		5						
B)		5						
C)		5						
D)		0						
E)		1						
F)		1						
G)		1						
H)		1						
I)		5						
J)		4						
K)		0						
L)		0						
M)		3						
N)		3						
O)		3						
P)		0						
Q)		0						
R)		3						
S)		0						
T)		3						
U)		5						
V)		5						
W)		0						
X)		0						

3 A) STAFF									
SUPERVISOR									
OPERATOR									
B) STAFF									
SUPERVISOR									
OPERATOR									
C) STAFF									
SUPERVISOR									
OPERATOR									
D) STAFF									
SUPERVISOR									
OPERATOR									
E) STAFF									
SUPERVISOR									
OPERATOR									
F) STAFF									
SUPERVISOR									
OPERATOR									
G) STAFF									
SUPERVISOR									
OPERATOR									
H) STAFF									
SUPERVISOR									
OPERATOR									
I) STAFF									
SPERVISOR									
OPERATOR									
J) STAFF									
SUPERVISOR									
OPERATOR									

K) STAFF									
SUPERVISOR									
OPERATOR									
L) STAFF									
SUPERVISOR									
OPERATOR									
M) STAFF									
SUPERVISOR									
OPERATOR									
N) STAFF									
SUPERVISOR									
OPERATOR									
O) STAFF									
SUPERVISOR									
OPERATOR									
P) STAFF									
SUPERVISOR									
OPERATOR									
Q) STAFF									
SUPERVISOR									
OPERATOR									
R) STAFF									
SPERVISOR									
OPERATOR									

Appendix 5.

CHECK SHEET

			~ 60	61 ~ 79	80 ~ 89	90 ~	EVALUATION
FOR RESULT (PRODUCT/SERVICE)	CLAIM AFTER DELIVERY OR SHIPPMENT	SERIOUSNESS OF TROUBLE	OBSERVED MARKET CLAIM OR LINE STOP, AND GIVE VERY SERIOUS TROUBLE	HAPPENED MANUAL REPAIR OR SELECTING INSPECTION ON EVERY MONTH	OBSERVED TROUBLE 1 on 3~6 MONTHS	NO PROBLEM ALL YEAR AROUND	
		OBSERVATION	VERY OFTEN	OFTEN	A FEW	NONE	
	PROCESS FAILURE	FAILURE RATE	10%	5%	1%	0.1%	
		MANUAL REPAIR	EVERY DAY	1 / WEEK	1 / MONTH	NONE	
		CONDEMNED COST	VERY AFFECT FOR PROFIT	RATHER MUCH	A FEW	NONE	
	DELIVERY	LATE DELIVERY OR NONE DELIVERABLE	OBSERVED EVERY DAY AND DELIVERED BY SP. VEHICLE	1 / WEEK	1 / MONTH	NONE	
	COST	PRODUCTIVITY	~ 69	70 ~ 89	90 ~ 99	100	
		PRODUCTION CAPACITY	BY INCREASING EMPLOYEE	BY OVER-TIME	JUST ACHIEVED BY PRESENT	ACHIEVED MORE THAN GOAL BY PRESENT	
FOR EQUIPMENT	EQUIP-MENT	MACHINE STOP	EVERY DAY	1~2/WEEK	1~2/MONTH	0/3~6 MONTH	
		SHORT STOP	WITHIN 1DAY	WITHIN 1HOUR	SOMETIME	NONE	
	TOOL & JIG	REPAIR	EVERY WEEK	EVERY MONTH	ONLY SCHEDULED	NONE FOR OTHER THAN SCHEDULED	
	DIE	EASINESS FOR USE	NEED EVERY DAY ADJUSTMENT	1 ADJUSTMENT PER EVERY DAY	1~2 / MONTH	NONE	

(CONTINUED)

CAUSES	FOR EQUIPMENT	INSPECTING TOOLS OR INSTRUMENT	PRECISIONNESS	CHECK EVERY DAY	CHECK EVERY MONTH	ONLY CALIBRATION	NO PROBLEM
		FOOL PROOF EQMT	ERROR OPERATION	HAPPENED EVERY DAY	EVERY WEEK	EVERY MONTH	NONE
(IN PROCESS CONTROL)		DAILY CHECK STATUS	CHECK SHEET	NONE AVAILABLE	PARTIALLY AVAILABLE	GENERAL CHECK SHEET ONLY	SPECIFICALLY USE CHECK SHEET
			IMPLEMENTATION STATUS	NONE	SOMETIMES IMPLEMENTED	SOMETIMES OMITTED	FOLLOW AS SOP
			CORRECTIVE ACTION RECORD	NONE	YES, BUT OMITTED SOMETIMES	YES, ONLY FOR SHOW	FOLLOW AS SOP
IMPLEMENTING PROGRAM	SOP & ITS	SOP	SOP	ALMOST NONE	AVAILABLE, BUT NOT CURRENT	AVAILABLE, BUT SOME AREA ARE NOT CURRENT	AVAILABLE, AND CURRENT
			UNDERSTAND ABILITY	CAN'T FOLLOW	VERY HARD	ONLY WHEN READ CAREFULLY	CAN FOLLOW BY FRESH-MAN
			PROCESSING ATTITUDE FOR SOP PREPARATION	FURNISH W/O CONSULTING WITH SHOP-FLOOR	ACTIVELY NOT ABSORB WORK-SHOP OPINION	ACTIVELY ABSORB WORK-SHOP OPINION	PREPARE SOP WITH JOINTLY WORK-SHOP
	EDUCATION AND	TRAINING	PLANNING SHEET	NONE	AVAILABLE, BUT DISREGARDED	AVAILABLE, BUT SOME ARE NOT FOLLOWED	FOLLOWED AS PLANNED
			IMPLEMENTING STATUS	~60%	60%	80%	100%
			FOR FRESHMAN	NONE	OJT BY EXPERIENCE	ONLY CRITICAL OPN.	FOLLOWED AS PLANNED
CONTROL	CONTROLLING DATA		SPECIFYING QUALITY TO BE CHECKED	NOT SPECIFIED	SOMETIMES NOT CLEARLY STATED	ONLY SKILLED OPERATOR BE UNDERSTANDING	CAN FOLLOW WHAT IT IS

(CONTINUED)

FOR CAUSES	CONTROL		DATA COLLECTION PROCEDURE	NOT SPECIFIED	NOT SPECIFIED BUT COLLECTED	SPECIFIED, AND PARTIALLY FOLLOWED	FOLLOWED AS SPECIFIED
		QC METHODS	FISH-BONE CHART	NONE USED	BEGIN TO USE	AVAILABLE, BUT NOT FULLLY UTILIZED	USED DAILY
			STRATIFI-CATION	DITTO	DITTO	DITTO	DITTO
			CHECK SHEET	DITTO	DITTO	DITTO	DITTO
			PARET DIAGRAM	DITTO	DITTO	DITTO	DITTO
			HISTOGRAM	DITTO	DITTO	DITTO	DITTO
			GRAPH	DITTO	DITTO	DITTO	DITTO
			SCATTER DIAGRAM	DITTO	DITTO	DITTO	DITTO
			OTHERS	DITTO	DITTO	DITTO	DITTO
ENVIRONMENT	ENVIRONMENT	5S	FLOOR, PASSAGE	ALMOST NOT IMPLEMENTED	JUST BEGIN	WELL KEPT MAINTAINED	THE 3RD PARTY ARE VISITING TO LOOK AT FOR MODEL
			EQUIPMENT	DITTO	DITTO	DITTO	DITTO
			PRODUCTS PROCEDURE	DITTO	DITTO	DITTO	DITTO
			PRODUCTS APPEARANCE	ROUGH HANCLING GET SCRATCH	PROPERLY CREATED SOMETIMES NOT FOLLOWED	SOP SPECIFIED AND FOLLOWED	TRIED IMPROVED FOR PREVENTION METHOD
			SWEEPING	NONE CONDUCTED	YES, BUT NO SOP	SOP ESTABLI-SHED BUT NOT FOLLOWED	FOLLOWED AS SOP
MORALE	MORALE	QC CIRCLE	NO. OF CIRCLE	0	JUST INSTALLED 50% >	50%>	ALL EMPLOYEE
			PARTICIPA-TION RATIO	0	>50%	50%>	100%
			THEME ESTABLISHED	0	6 >	2 > PER 6 MONTHS	4 > PER YEAR

MORALE	MORALE	QC CIRCLE	CASE PRESENTATION	NONE	PRESENT AT DEPARTMENT-WIDE MEETING	PRESENT AT COMPANY-WIDE MEETING	PRESENT AT OUTSIDE MEETING	
			FINISHED THEME	NONE	NOT ACHIEVED	ACHIEVED GOAL	BETTER THAN GOAL ACHIEVED	
IMPROVEMENT	IMPROVING PROGRAM	ANNUAL PLAN	ANNUAL POLICY PLAN	NONE	BEGIN TO IMPLEMENT	YES, BUT NO FOLLOW PDCA CYCLE	YES, AND FOLLOW PDCA CYCLE	
			PROGRAM	NONE	YES, BUT NOT BE FOLLOWED	YES, BUT NOT ACHIEVED	YES, AND ACHIEVED AS PLANNED	
			RESULT	NONE	NOT ACHIEVED BADLY	ACHIEVED	ACHIEVED	

1. The aboves will be used at each surveying plant.

2. Interview will be conducted for management, supervisor or Engineers whoever be available.

3. The aboves are mainly utilized at production-industry (specially at Vehicle-Industry in Japan), for surveying Quality Improvement, Delivery Control, & Cost-Reduction Activity status identification. Cost-Reduction Activity Status Identification.

Translated by
I. Miyauchi

For Mr. Yoshikawa's originated check list for evaluation

表3 表3 No1 4 NO.2 NO.3 7 NO.4 9

Appendix 6.

				PHILCO 2/9	25 Schlumberger	RIMA	Teleme Canyon	Quebec rail or
FOR RESULT (PRODUCT/SERVICE)	CLAIM AFTER DELIVERY OR SHIPPMENT		SERIOUSNESS OF TROUBLE	C	B	C	B	A
			OBSERVATION	C	B	B	B	—
	PROCESS FAILURE		FAILURE RATE	C	B	C	C	A
			MANUAL REPAIR	D	B	D	D C.	A
			CONDEMNED COST	B	B	A	A	A
	DELIVERY		LATE DELIVERY OR NONE DELIVERABLE	Not	A	C	D C	B
	COST		PRODUCTIVITY	B	B	C . A	D C	—
			PRODUCTION CAPACITY	B	B	C	C	B
FOR	FOR EQUIPMENT	EQUIPMENT	MACHINE STOP	A 設備なし	B	B	C B	C
			SHORT STOP	C	B	B	C	C
		TOOL & JIG	REPAIR	D.	B	B C	C.	—
		DIE	EASINESS FOR USE	B	B	/	B	—

				PiliCo 2/9	Schlumberger	Rinsa	Telecanique	Qalimbuzant
CAUSES (INPROCESS · CONTROL)	FOR EQUIPMENT	INSPECTING TOOLS OR INSTRUMENT	PRECISIONNESS	B	B	D C B	D A	C B
		FOOL PROOF EQMT	ERROR OPERATION	-	A	B	B A	B
		DAILY CHECK STATUS	CHECK SHEET	A	A	A	B A	A
			IMPLEMENTATION STATUS	A	B	A	B A	A
			CORRECTIVE ACTION RECORD	A	C	A	B	A
	SOP & ITS IMPLEMENTING PROGRAM	SOP	SOP	A	A	A	A	A
			UNDERSTANDABILITY	B	A	A	A	A
			PROCESSING ATTITUDE FOR SOP PREPARATION	B	A	B	D	A
		EDUCATION AND TRAINING	PLANNING SHEET	A	B	A	B	A
			IMPLEMENTING STATUS	A	B	A	C	B
			FOR FRESHMAN	A	A	C	B	A
	CONTROL	CONTROLLING DATA	SPECIFYING QUALITY TO BE CHECKED	A	A	A	B	A

FOR CAUSES	CONTROL	QC METHODS	DATA COLLECTION PROCEDURE	A	B	A	B A	A
			FISH-BONE CHART	C	B	C	B	A
			STRATIFICATION	A	A	D	B	A
			CHECK SHEET	A	A	A	A	A
			PARET DIAGRAM	A	B	B	A	B
			HISTOGRAM	A	B	B	A	B
			GRAPH	A	A	D	A	A
			SCATTER DIAGRAM	D	A	D	D	A
			OTHERS	A	B	D	A	D
ENVIRONMENT	ENVIRONMENT	5 S	FLOOR, PASSAGE	B	B	B	B	B A
			EQUIPMENT	B	A	B	B	C
			PRODUCTS PROCEDURE	A	B	B	B	A
			PRODUCTS APPEARANCE	B	B	B	B	A
			SWEEPING	B	A	A	A	A
MORALE	MORALE	QC CIRCLE	NO. OF CIRCLE	D	C	D	C	D
			PARTICIPATION RATIO	D	B	D	C	D
			THEME ESTABLISHED	D	A	D	A	D other

MORALE	MORALE	QC CIRCLE	CASE PRESENTATION	D	C	D	B A	A
			FINISHED THEME	D	B	D	B	A
IMPROVEMENT	IMPROVING PROGRAM	ANNUAL PLAN	ANNUAL POLICY PLAN	A	B	B	B	A
			PROGRAM	A	B	A	B	A
			RESULT	A	B	B	B	A

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Translated by
I. Miyauchi

For Mr. Yoshikawa's
originated check
list for evaluation

			No6 3/? NEC MTS	NO.7 NEC MECHANICAL	NO.5 SIH	NO.9 MULTIPLEX	NO.10 MERA[illegible]
FOR RESULT (PRODUCT / SERVICE)	CLAIM AFTER DELIVERY OR SHIPPMENT	SERIOUSNESS OF TROUBLE	D B	B	C	B	B
		OBSERVATION	/	B		B	B
	PROCESS FAILURE	FAILURE RATE	/	B	B	A	A
		MANUAL REPAIR	/	C	B	C	A
		CONDEMNED COST	B	B	B	B	A
	DELIVERY	LATE DELIVERY OR NONE DELIVERABLE	B	B	B	B	A
	COST	PRODUCTIVITY	C	C	B	B	
		PRODUCTION CAPACITY	C	C	C B	B	A
FOR FOR EQUIPMENT	EQUIPMENT	MACHINE STOP	/	A		/	
		SHORT STOP	/	B		/	
	TOOL & JIG	REPAIR	B	B	B	B	B
	DIE	EASINESS FOR USE	/	B			

				NEC 30'9 MTS				
CAUSES (IN PROCESS · CONTROL)	FOR EQUIPMENT	INSPECTING TOOLS OR INSTRUMENT	PRECISIONNESS	B	A	B	B	B
		FOOL PROOF EQMT	ERROR OPERATION	–	B	B	/	A
		DAILY CHECK STATUS	CHECK SHEET	B	B	A	A	A
			IMPLEMENTATION STATUS	B	A	A	A	B
			CORRECTIVE ACTION RECORD	A	A	A	A	A
	SOP & ITS IMPLEMENTING PROGRAM	SOP	SOP	B	A	A	A	A
			UNDERSTAND ABILITY	A	B	B	A	A
			PROCESSING ATTITUDE FOR SOP PREPARATION	A	B	B A	B	C
		EDUCATION AND TRAINING	PLANNING SHEET	B	B	B	B	B
			IMPLEMENTING STATUS	C	B	C	C	C
			FOR FRESHMAN	B	C	A	C A	C
	CONTROL	CONTROLLING DATA	SPECIFYING QUALITY TO BE CHECKED	C	A	A	A	A

FOR CAUSES	CONTROL	QC METHODS	DATA COLLECTION PROCEDURE	B	A	B	A	A
			FISH-BONE CHART	/	B	B	B	D
			STRATIFI-CATION	B	B	B	A	D
			CHECK SHEET	A	C	B	A	B
			PARET DIAGRAM	A	B	B	A	D
			HISTOGRAM	A	C	B	B	D
			GRAPH	A	A	B	A	B
			SCATTER DIAGRAM	D	C	B	C	D
			OTHERS	D	B	B	A	D
ENVIRONMENT	ENVIRONMENT	5 S	FLOOR, PASSAGE	-	B	C	C	C
			EQUIPMENT	-	B	B	B	C
			PRODUCTS PROCEDURE	-	B	B	B	C
			PRODUCTS APPEARANCE	-	B	B	B	B
			SWEEPING	-	B	A	C B	C
MORALE	MORALE	QC CIRCLE	NO. OF CIRCLE	-	C	D	C B	D
			PARTICIPA-TION RATIO	-	C	D	C B	D
			THEME ESTABLISHED	-	C	D	C B	D

MORALE	MORALE	QC CIRCLE	CASE PRESENTATION	-	B	D	E	D
			FINISHED THEME	-	B	D	C	D
IMPROVEMENT	IMPROVING PROGRAM	ANNUAL PLAN	ANNUAL POLICY PLAN	B	A	B	B	A
			PROGRAM	B	B	B	B	B
			RESULT	C	B	C B	B A	D

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Translated by
I. Miyauchi

For Mr. Yoshikawa's originated check list for evaluat.

			NO11 4/10	NO12 5/10	No.13	NO14	NO.15
			PHILIPS	TOKO sc	TOKO Eng	TOKO 3	ARNO
FOR RESULT (PRODUCT/SERVICE)	CLAIM AFTER DELIVERY OR SHIPPMENT	SERIOUSNESS OF TROUBLE	B	B	B	/	C
		OBSERVATION	B	B	B	/	B
	PROCESS FAILURE	FAILURE RATE	C	C	C B	[illegible]	B
		MANUAL REPAIR	B A	B	C	/	C
		CONDEMNED COST	B	A	B	/	B
	DELIVERY	LATE DELIVERY OR NONE DELIVERABLE	[illegible] A	B	B	D	C
	COST	PRODUCTIVITY	B	A	/	/	C
		PRODUCTION CAPACITY	A	C	~~D~~ C	C	C
FOR	FOR EQUIPMENT: EQUIP-MENT	MACHINE STOP	[illegible]	C	C	/	B
		SHORT STOP	C	C	B	/	C
	TOOL & JIG	REPAIR	D	B	D	/	C
	DIE	EASINESS FOR USE	B	C	B	/	B

CAUSES (INPROCESS · CONTROL)	FOR EQUIPMENT	INSPECTING TOOLS OR INSTRUMENT	PRECISIONNESS	B	B	B	/	B
		FOOL PROOF EQMT	ERROR OPERATION	B	A	A	/	C
		DAILY CHECK STATUS	CHECK SHEET	b	A	A	/	A
			IMPLEMENTATION STATUS	B	B	B	/	A
			CORRECTIVE ACTION RECORD	C	C	C	/	A
	SOP & ITS IMPLEMENTING PROGRAM	SOP	SOP	A	B	B	B	A
			UNDERSTAND ABILITY	B	B	B	B	B
			PROCESSING ATTITUDE FOR SOP PREPARATION	B	B	B	B	B
		EDUCATION AND TRAINING	PLANNING SHEET	A	C	D	C	A
			IMPLEMENTING STATUS	B	C	C	C	A
			FOR FRESHMAN	B	C	B	C	A
	CONTROL	CONTROLLING DATA	SPECIFYING QUALITY TO BE CHECKED	A	B	C	/	A

FOR CAUSES	CONTROL	QC METHODS	DATA COLLECTION PROCEDURE	A	A	B	/	A
			FISH-BONE CHART	B	B	B	/	D
			STRATIFICATION	B	C	B	/	B
			CHECK SHEET	C	A	A	/	A
			PARET DIAGRAM	A	A	B	/	A
			HISTOGRAM	A	B	B	/	C
			GRAPH	A	A	A	/	A
			SCATTER DIAGRAM	A	C	D	/	D
			OTHERS	A	C	D	/	D
ENVIRONMENT	ENVIRONMENT	5 S	FLOOR, PASSAGE	B	C	C	C	A
			EQUIPMENT	B	C	B	B	B
			PRODUCTS PROCEDURE	B	B	B	/	A
			PRODUCTS APPEARANCE	B	B	B	/	B
			SWEEPING	C	C	C	B	B
MORALE	MORALE	QC CIRCLE	NO. OF CIRCLE	C	C	C	C	D
			PARTICIPATION RATIO	C	C	C	C	D
			THEME ESTABLISHED	C	C	A	A	D

MORALE	MORALE	QC CIRCLE	CASE PRESENTATION	C	B	B	C	A
			FINISHED THEME	B	B	B	B	A
IMPROVEMENT	IMPROVING PROGRAM	ANNUAL PLAN	ANNUAL POLICY PLAN	B	A	B	C	B
			PROGRAM	B	B	B	B	A
			RESULT	B	B	B	C	A

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list for evaluation

Appendix 7.

				D	C	B	A	
FOR RESULT (PRODUCT/SERVICE)	CLAIM AFTER DELIVERY OR SHIPPMENT		SERIOUSNESS OF TROUBLE	/	////	卌 ////	//	
			OBSERVATION		/	卌 卌 //		
	PROCESS FAILURE		FAILURE RATE		卌 /	卌 /	卌 /	
			MANUAL REPAIR	///	卌	卌 /	///	
			CONDEMNED COST	/	/	卌 卌	卌	
	DELIVERY		LATE DELIVERY OR NONE DELIVERABLE	/	///	卌 ////	//	
	COST		PRODUCTIVITY	/	卌	////	///	
			PRODUCTION CAPACITY	/	卌 卌 /	卌	//	
FOR	FOR EQUIPMENT	EQUIP-MENT	MACHINE STOP	/	卌	卌	//	
			SHORT STOP		卌 //	卌 /		
		TOOL & JIG	REPAIR	///	///	卌 ////		
		DIE	EASINESS FOR USE		/	卌 //		

				D	C	B	A	
FOR CAUSES	CONTROL		DATA COLLECTION PROCEDURE			卌	卌卌 ||	
		QC METHODS	FISH-BONE CHART	|	||||	卌 ||||	|	
			STRATIFICATION	||	|||	卌 ||	|||||	
			CHECK SHEET		|||	||	卌卌 |	
			PARET DIAGRAM	|	||	卌 |	卌 |||	
			HISTOGRAM	|	||	卌 ||	|||||	
			GRAPH	|		|||	卌卌 ||	
			SCATTER DIAGRAM	卌 |||	|||	|	|||	
			OTHERS	卌 ||	||	|||	|||	
ENVIRONMENT	ENVIRONMENT	5S	FLOOR, PASSAGE		卌 |||	卌 ||	||	
			EQUIPMENT		||||	卌 卌 |	|	
			PRODUCTS PROCEDURE		||	卌 卌	|||	
			PRODUCTS APPEARANCE			卌 卌 ||||	|	
			SWEEPING		卌 |	||||	卌 |	
MORALE	MORALE	QC CIRCLE	NO. OF CIRCLE	卌 |||	卌 |||	|		
			PARTICIPATION RATIO	卌 ||	卌 ||	||		
			THEME ESTABLISHED	卌 |||	||||	|	|||	

				D	C	B	A	
CAUSES (INPROCESS. CONTROL)	FOR EQUIPMENT	INSPECTING TOOLS OR INSTRUMENT	PRECISIONNESS	///	//	卌卌 ///	///	
		FOOL PROOF EQMT	ERROR OPERATION			卌 //	卌 //	
		DAILY CHECK STATUS	CHECK SHEET			////	卌卌 //	
			IMPLEMENTATION STATUS			卌 //	卌 卌	
			CORRECTIVE ACTION RECORD		////	/	卌 卌 //	
	SOP & ITS IMPLEMENTING PROGRAM	SOP	SOP			////	卌 卌 //	
			UNDERSTANDABILITY			卌 ///	卌 ////	
			PROCESSING ATTITUDE FOR SOP PREPARATION	/	/	卌 卌	卌 /	
		EDUCATION AND TRAINING	PLANNING SHEET	/	//	卌 ///	卌 /	
			IMPLEMENTING STATUS		卌 ////	///	////	
			FOR FRESHMAN		卌 ///	卌 /	卌 ///	
	CONRTOL	CONTROLLING DATA	SPECIFYING QUALITY TO BE CHECKED		//	//	卌 卌 //	

MORALE	MORALE	QC CIRCLE	CASE PRESENTATION	𝍸 /	////	////	//	
			FINISHED THEME	𝍸	/	𝍸 ///	/	
IMPROVEMENT	IMPROVING PROGRAM	ANNUAL PLAN	ANNUAL POLICY PLAN		/	𝍸 𝍸 /	𝍸	
			PROGRAM			𝍸 𝍸 /	𝍸 /	
			RESULT		//	𝍸 ///	𝍸 /	

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For Mr. Yoshikawa's originated check list for evaluation

2-Week Training Program
JUSE-UNIDO-FCAV
March 6 - 17, 1995
at JUSE Higashi Koenji Annex
(Tel:03-5378-1211, Fax:03-5378-1220)

		(Lecturer)
6 March, (Mon)		
09:30-12:30	General Concept of TQC	Dr. Yasutoshi Washio
13:30-16:30	"	Mr. Ichiro Miyauchi
7 March, (Tue)		
09:30-12:30	Policy Management	Dr. Yoshikazu Tsuda
13:30-16:30	Daily Work Management	"
16:45-19:30	Group Discussion	
8 March, (Wed)		
09:30-12:30	Quality Assurance	Dr. Tadashi Yoshizawa
13:30-16:30	Standardization	Mr. Ichiro Miyauchi
9 March, (Thu)		
09:30-12:30	Process Control	Mr. Hideo Yoshikawa
13:30-16:30	Role of TQC Facilitators	Mr. Ichiro Miyauchi
16:45-19:30	Group Discussion	
10 March, (Fri)		
09:30-12:30	QC Circle Activities	Mr. Ichiro Miyauchi
13:30-16:30	Q & A	"
16:45-18:30	Farewell Party	

11 & 12 March, (Sat) & (Sun) Holiday

13 March, (Mon) 13:30-16:30	Kyosan Denki Co., Ltd. (Koga, Ibaragi Pref.)
14 March, (Tue) 13:30-16:30	Jatco Corporation (Fujinomiya, Shizuoka Pref.)
15 March, (Wed) 13:00-16:00	Yamato Kogyo Co., Ltd.(Oyama, Tochigi Pref.)
16 March, (Thu) 10:00-15:00	Mitsubishi Electric Building Techno-Service Co., Ltd. (Tokyo)
17 March, (Fri)	Q & A and final Wrap-up meeting

ブラジル Vanzolini財団 TQC研修コース
メンバーリスト

NO	NAME	Position	Organization,Company
1	Melvin Cymbalista	Vice-President	Fundacao Carlos Alberto Vanzolini
2	Jose Joaquim do Amarai Ferreira	Director	Fundacao Carlos Alberto Vanzolini
3	Osnir Simonatto	Project - Coordinator	Fundacao Carlos Alberto Vanzolini
4	Ricardo Valente da Silva	Project - Coordinator	Fundacao Carlos Alberto Vanzolini
5	Cleber Garcez	Project - Coordinator	Fundacao Carlos Alberto Vanzolini
6	Paulino Francischini	Project - Coordinator	Fundacao Carlos Alberto Vanzolini
7	Robson Barceios	Quality Manager	Grupo Itautec - Philco (consumer electronics,micro computers)
8	Klaus Billand	Director	UNIDO in Brazil

Appendix 10.

2-WEEK TRAINING COURSE

FOR FCAV, UNID PROJECT

MARCH 6-17, 1995

LECTURERS' LIST

UNION OF JAPANESE SCIENTISTS AND ENGINEERS

Dr.Yasutoshi WASHIO

1. Outline of career

1929 Born in Yamaguchi

1953 Graduated from Kyushu University, Faculty of Physical Science, Department of Mathematics

1958 Joined in Asahi Chemical Industry Co., Ltd.

1961 Assistant Professor of Keio University, Faculty of Enginering

1973 Professor of Keio University

1993 Recieved Deming Prize(for Individuals)

1994 up to date
Professor of Niigata university of International/Information Studies

2. Activities in QC

* Deming Prize Medalist of 1993
* Member of Deming Application Prize Sub-Committee
* lecturer of QC Basic Course, Middle Management Course, Design of Experiment, etc. organized by JUSE
* Member of Editorial Committee of 'Total Quality Control'

Mr. Ichiro MIYAUCHI

1. Outline of career

1918	Born in Saga
1940	Graduated from Yokohama Technical College Department of Aeronautical Engineering
1940	Nakajima Aircraft Mfg. Co.
1947	Tokyo Bantam Car Co.
1951	U.S.A.F. Tachikawa Air Base, QC Consultant Engineer
1960	Ishikawajima-Harima Heavy Industries, Co. QC Manager, TQC Manager
1979	up to date Counselor of Union of Japanese Scientists and Engineers

2. Activities in QC

* Member of Japanese Society for Quality Control
* Certified Reliability Engineer of Society for Quality Control, U.S.A.
* Senior Logistic Engineer of Society of logistic Engineer, U.S.A.

Dr.Yoshikazu TSUDA

1.Outline of Career

1935 Born in Kobe

1957 Graduated from Osaka City
University,Faculty of Mathmatics ,specialzed in Physical Science and Engineers

1961 Investigation Committee of Atomic Bomb Injury.

1962 AssistantProfessor of Nihon University,Faculty of Physical Science

1965 Assistant of Tokyo Metropolitan University,Faculty of Phsical Science

1993 up to date
Professor of Rikkyo University,Department of Teaching ,
Statistical Faculty of Computer Science and Mathmatics

2. Activities in QC

*Member of Japanese Society for Quality Control
*Member of American Siciety for Quality Control

Dr. Tadashi Yoshizawa

1. Outline of career
   - 1939 Born in Tokyo
   - 1962 Graduated from the University of Tokyo , Faculty of Engineering, Applied Physics Department
   - 1966 Tutor at the University of Tokyo
   - 1978 Professor at Yamanashi University, Faculty of Engineering, Computer Science Department
   - 1989 up to date Professor at Tsukuba University
2. Activities in QC
   - ‡ Member of Japanese Society for Quality Control
   - ‡ Member of American Society for Quality Control
   - ‡ Member of International Statistical Institute
   - ‡ Chairman of Organizing Committee of Multivariate Analysis Study Meeting, JUSE
   - ‡ member of Organizing committee of QFD and SPC Study Meeting and basic course, JUSE

9

Mr. Hideo YOSHIKAWA

1. Outline of career

1926	Born in Niigata
1948	Graduated Taga Technical College, Mechanical Engineering Department
1948	Joined Ministry of International Trade and Industry
–	Joined Nissan Diesel Motor Co., Ltd.
–	up to date
	President of Intellect Co., Ltd.

2. Activities in QC

* Member of Japanese Society for Quality Control
* Lecturer of QC Basic Course, Middle Management Course, Executive Course, etc. organized by JUSE
* Member of Editorial Board of the magazine "Total Quality Control"

TQC TRAINING COURSE FOR FCAV. UNIDO PROJECT
MARCH 6 (Mon) - 17(Fri). 1995

Subject to be Discussed

To implement TQC concept into your company. What kind of difficulty is anticipated under your own situation?

Through brain-storming. identify top 2 difficulties.

Then. establish corrective or recommending actions for these top 2 with priority.

Group Discussion S.O.P.

Step 0:Introduce yourself each other

Step 1:Select group-leader. recorder and presentator

Step 2:Under group-leader's guidance. proceed on identification of anticipating difficulties at each companies through brain-storming method.

Step 3:Stratify the difficulties identified by 4M/1E category(Man.Machine. Material.Method and Environment)and reconsider if any omission or duplication on identified ones.

Step 4:Prioritize top 5 among those difficulties by "Matrix Method".

Step 5:Again by brain-storming. identify corrective and recommending actions for each 2 top difficulties.

Step 6:Prioritize each actions as
(1)Firstly. pick up inplementable corrective actions by your own dicision.
(2)Secondarily by using "Matrix Method". again establish critical and important corrective actions for each difficulties while specifying the necessary actions by 5W 1H approach. as shown in the attached table.

Step 7:Prepare reports for presentation.

TIME ALLOCATION

March 7 (Tue) 16:45-19:30	Group discussion orientation Brain-storming for identification of difficulties
March 9 (Thu) 16:45-19:30	Prioritization of top 5 Brain-storming for identification of corrective or recommending actions for top 5 Prioritization of corrective actions Preparation of reporting papers
March 17 (Fri) 09:30-12:30	Presentation and evaliation of group discussion

Priority	Corrective Action	Why	Who	What	Where	When	How
1							
2							
3							
4							
....							
N							

MATRIX TYPE PRIORITIZATION METHOD

FOR IMPLEMENTATION OF TQC / FOR CO.'S SITUATION		IF NOT CORRECTED THIS DIFFICULTY, TQC WOULD NOT BE IMPLEMENTED	IF NOT CORRECTED, TQC WOULD BE VERY HARD TO IMPLEMENT	IF NOT CORRECTED, TQC WOULD BE HARD TO IMPLEMENT
		A	B	C
NEVER TAKE ANY ACTION YET	X	100 20	40 8	20 4
ACTION WAS TAKEN BUT SUSPENDED	Y	40 8	20 4	10 2
ACTION WAS TAKEN BUT NOT EFFECTIVE	Z	20 4	10 2	5 1

TALLY SHEET

	A			B			C			Σ	RATING
	(20)	(8)	(4)	(8)	(4)	(2)	(4)	(2)	(1)		
	X	Y	Z	X	Y	Z	X	Y	Z		
1	/// 60			/// 24	/ 4		/// 12			100	③
2	// 40			~~////~~ 40			// 8		/ 1	89	④
3	// 40			// 16		/ 2	~~////~~ 20			78	
4				~~////~~ ~~////~~ 80						80	⑤
⋮											
50	~~////~~ ~~////~~ 200									200	①
⋮											
N	~~////~~ 100			~~////~~ 40						140	②

Appendix 12.

EVALUATION SHEET

1. With respect to the seminar, please put a mark "O" on the number in the following table:

No.	SUBJECT AND LECTURER	DEGREE OF YOUR UNDERSTANDING (good←→poor)					8 Participants AVERAGE	INSTRUCTIVENESS OF THE LECTURE (good←→poor)					8 Participants AVERAGE
1	General Concept of TQC by Y. Washio	5	4	3	2	1	4.12	5	4	3	2	1	3.75
2	General Concept of TQC by I. Miyauchi	5	4	3	2	1	4.25	5	4	3	2	1	3.87
3	Policy Management by Y. Tsuda	5	4	3	2	1	3.75	5	4	3	2	1	3.37
4	Daily Work Management by Y. Tsuda	5	4	3	2	1	3.75	5	4	3	2	1	3.62
5	Quality Assurance by T. Yoshizawa	5	4	3	2	1	4.37	5	4	3	2	1	4.5
6	Standardization by I. Miyauchi	5	4	3	2	1	4.5	5	4	3	2	1	4.0
7	Process Control by H. Yoshikawa	5	4	3	2	1	4.5	5	4	3	2	1	4.5
8	Role of TQC Facilitators by I. Miyauchi	5	4	3	2	1	4.75	5	4	3	2	1	4.37
9	QC Circle Activities by I. Miyauchi	5	4	3	2	1	4.12	5	4	3	2	1	4.00

Data

EVALUATION SHEET

JUSE TQC SEMINAR FOR BRAZIL MIDDLE MANAGEMENT AND TQC COORDINATORS

1. With respect to the seminar, please put a mark "○" on the number in the following table:

No.	SUBJECT AND LECTURER	DEGREE OF YOUR UNDERSTANDING (good←→poor)					INSTRUCTIVENESS OF THE LECTURE (good←→poor)				
1	General Concept of TQC 4.12 / 3.75 by Y. Washio	T 5	正 4	一 3	2	1	一 5	正 4	一 3	一 2	1
2	General Concept of TQC 4.25 / 3.87 by I. Miyauchi	下 5	止 4	一 3	2	1	T 5	下 4	下 3	2	1
3	Policy Management 3.75 / 3.37 by Y. Tsuda	T 5	T 4	止 3	2	1	一 5	下 4	T 3	T 2	1
4	Daily Work Management 3.75 / 3.62 by Y. Tsuda	一 5	止 4	下 3	2	1	T 5	下 4	一 3	T 2	1
5	Quality Assurance 4.37 / 4.5 by T. Yoshizawa	止 5	下 4	一 3	2	1	正 5	T 4	一 3	2	1
6	Standardization 4.5 / 4.00 by I. Miyauchi	止 5	止 4	3	2	1	一 5	正 4 一	一 3	2	1
7	Process Control 4.5 / 4.5 by H. Yoshikawa	止 5	止 4	3	2	1	正 5	T 4	一 3	2	1
8	Role of TQC Facilitators 4.75 / 4.37 by I. Miyauchi	正 5 一	T 4	3	2	1	止 5	下 4	一 3	2	1
9	QC Circle Activities 4.12 / 4.00 by I. Miyauchi	一 5	正 4 T	3	2	1	T 5	止 4	T 3	2	1

2. PLANT VISIT

o Were you satisfied with plant visit program?
☐ Satisfied ☐ Not Satisfied

o If you were not satisfied, describe its reasons below.

2-WEEK TRAINING COURSE
FOR FCAV, BRAZIL
UNIDO PROJECT
(TF/BRA/92/B10, DP/BRA/92/004)

GENERAL CONCEPT OF TQC

Yasutoshi WASHIO

NIIGATA UNIVERSITY OF
INTERNATIONAL/INFORMATION STUDIES

UNION OF JAPANESE SCIENTISTS AND ENGINEERS

UNION OF JAPANESE SCIENTISTS AND ENGINEERS
(NIPPON KAGAKU GIJUTSU RENMEI)
5-10-11, Sendagaya, Shibuya-ku, Tokyo 151, JAPAN

1. Introduction

- Until about fifteen years ago. Japanese manufactured products had reputation of being "low in price and low in quality". However. nowadays. Japanese products have been assessed as being "low in price and high in quality". As a result. the level of Japanese exportation of products has increased causing trade friction with some countries.

- Many factors have contributed to the dramatic success of Japanese manufacturing industry. However. according to Japanese top executives. a major contributer has been Quality Control Activities in Japanese industries.

- Quality Control(QC) was introduced to Japan by the United States. Dr. Deming in 1950. Japan has succeeded in developing a "Japanese QC system (called TQC)" which incorporates its social construction. national characteristics and educational standards through trial and error.

- Definition of TQC:
  - (i) high quality of the product or the service which meets customers' needs
  - (ii) provide at the low cost(reasonable cost)
  - (iii) company-wide activities

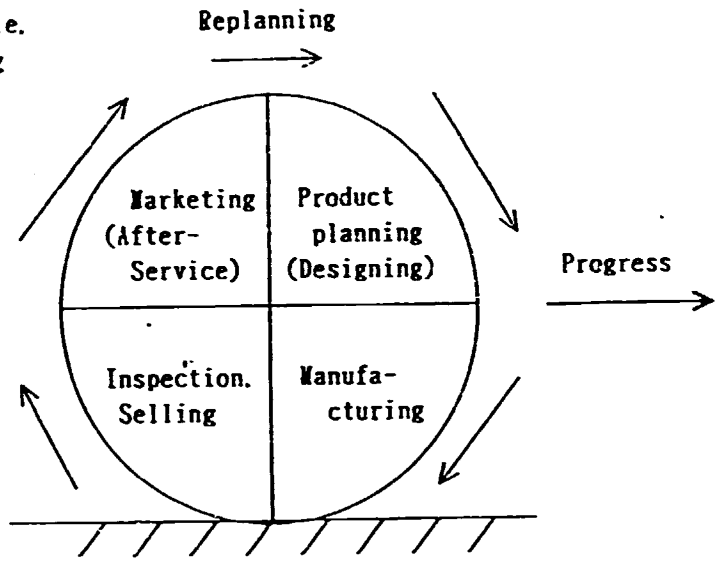
- TQC consists of the three elements:
  - QC ways of thinking.
  - TQC system.
  - QC tools

2. The Characteristics of QC Activites in Japan

(1) Total Quality Control (Company-Wide QC)

- QC activities are performed by all the persons of an organization. from the president and the top executives to ordinary individual workers. And QC activities are performed by all the sections of an organization such as product development. product planning. manufacturing. sales. purchase. personnel. etc.

- Dr. Deming taught us this point by showing a circle, which we call "Deming Circle".



- In order to promote TQC, Top's leadership is very important. Most of the Top executives have the sound idea on TQC.

(2) The application of statistical methods in Quality Control(SQC)

- Statistical methods are effectively used in QC. Statistical methods applied in QC are as follows:

  (i)Basic Statistical methods (7 tools in QC)
  Histogram. Stratification. Pareto diagram. Cause-and-effect diagram. (Ishikawa's diagram). Check sheet. Graph(Control Chart). Scatter diagram

  (ii)Further statistical methods
  Control chart. Sampling inspection. Design of experiments. Regression analysis. Multivariate analysis. Reliability theory. etc.

- Not only specialists but also all the company employees are trained on statistical methods (at least 7 tools in QC). Quality improvement and cost reduction are the results of the application of statistical methods.

Among statistical methods, design of experiments is widely used to pursue the optimal design parameter values and production condition. In experiments, since the number of factors is large, most of the experiments are performed by using "Orthogonal Array" developed in Japan.

- Why are the statistical methods necessary and useful?

  (i) In modern QC, the control is not "Man Control" but "Fact Control".

  Fact = Data

  Therefore, before making any decision we have to collect date and analyze them. Then, statistical methods are necessary.

  (ii) The quality of manufactured products is always subject to a certain amount of variation due to many factors (4 M such as Machine, Man, Method and Material). We must control 4 M.

  Then, We have the following problems:

  (a) To what factor should we pay more attention?
  (b) At what level should we maintain or control the factor?

  For investigating these problems, statistical methods are useful and powerful.

(3) Concept of "Quality First"

- Of cource, we want to get much profit. However, "Profit" is just a result of our activities. As a means of getting much profit, we choose "Quality Improvement".

- The quality of a product must be determined on the basis of the consumer's opinion. We must plan and produce products which meet the consumer's needs For this purpose, a systematic activity to grasp the consumer's needs is performed. And the results are reflected in product planning or replanning the product

Now, it is the beginning of the age of quality competition.
We have to develop and produce products which satisfy customers ' needs.
Therefore, the concept of "Quality First" is essential. We may say that TQC is just "Quality Management".
To say that the improvement of quality will increase cost is not necessarily true (or a mistake). By improving the quality of products, we will simultaneously increase the selling volume, thus lowering cost of production.

(4) QC circle activities (one activity of Human Resource Management)

- QC circle is a small group consisting of five or eight persons to perform QC activities voluntarily within the same shopfloor to which they belong. Members in a QC circle are foremen and workers.

- QC activities in the shopfloor are carried out through the QC circle. QC circle has brought about good results in improving the quality or in reducing the manufacturing cost.

- QC circle utilizes elementary QC techniques such as "7 tools in QC" in "Problem Solving"

- 5 S house-keeping campaig

S orting(SEIRI)	S anitizing(SEIKETSU)
S ystematising(SEITON)	S elf-Disciplining(SHITSUKE)
S weeping(SEISOH)	

(5) Implementation of PDCA cycle in doing works

- Repeating the plan-do-check-action (PDCA) cycle incessantly improves product / work quality.

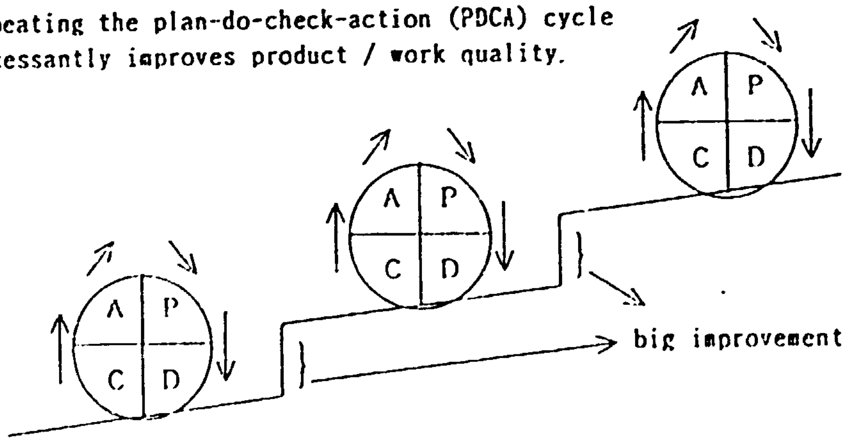


Figure 2.1 PDCA Cycle

- In TQC, the standardization (to set technical standards/operation standards) is very important. The quality of product should be built in by standards.

  The standards should be improved (changed) through the production year by year. The steps for standardization are as follows:

Plan	:	Set temporary standards
Do	:	Work by using the standards
Check	:	Observe the quality of manufactured products through the production
Action	:	If the quality is not satisfactory, alter the standards or set new standards temporarily. If the quality is satisfactory, we accept the standards.

- We may say that QC activities is how to use the cycle of P.D.C.A to enhance quality.

(6) Consistent Quality Assurance (QA) activities from New Product Planning/Development though After-Sales-Service

- Activities for QA are performed by all the sections (cross-functional management). Especially, we focus on the activities at the stage of New Product Planning/Development.

(7) Systematic education and training on Quaiity Control

- Much efforts are paid for education and training. All members in organization are trained on QC

  Education and training on QC are performed by four different levels such as Top Management, Middle Management, Staff, Foremen and Workers.

(8) Nation-wide activities (private activities) for promoting Quality Control

- Role of "Union of Japanese Scientists and Engineers (JUSE)" and "Japanese Standards Association(JSA)"
  Deming Prize
  QC symposium and QC convention (2 times/year)
  Seminars on QC
  Nation-wide organization for promoting QC circles
  Quality Month (November)

3. Historical perspective of Quality Control Activities in Japan from the view-point of Quality Assurance

(i) The 1st stage (1950-1955)
Emphasis of QC activities was on the inspection section.

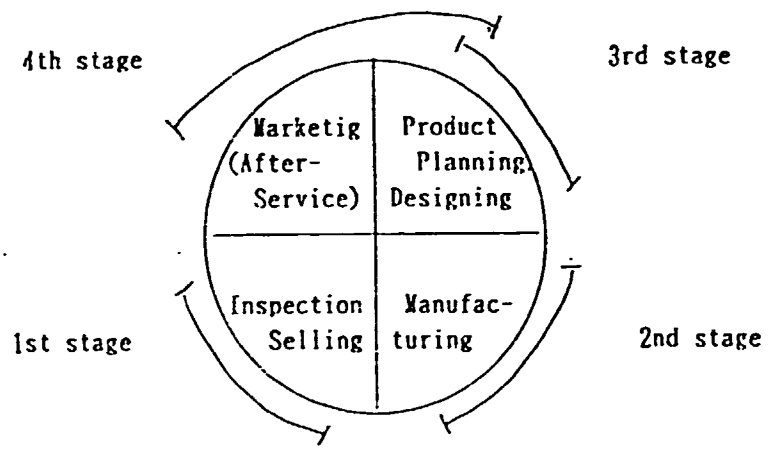
(ii) The 2nd stage (1956-1970)
Emphasis was on the manufacturing process.

(iii) The 3rd stage (1971-1980)
Emphasis was on the product planning and product designing.

(iv) The 4th stage (1981-)
Emphasis is on

i) Grasping customer's needs and reflecting them in product planning

ii) New product development



4. QC Ways of Thinking

1) What matters is not the appearance of a defective product (trouble). but the recurrence of the same defects caused by the same reoson.

2) Judgement on the basis of fact (Fact Control)

3) "Quality First " and not "profit First"

4) Concept of "Quality "

5) PDCA cycle

6) Concept of "Standardization "

7) Concept of "Market in " . In general. next down streams are customers.

8) Paying more attention to the process than the result.

9) Priority principle

5. TQC System

(1) Policy Deployment (Management by Policy)

- Policy deployment is generally for annual business management policy. The policy consists of goal to be accomplished plus major priority plan for attaining the goal.

- In deploying President's policy to each department, negotiation with upper/ lower levels and other departments should be done.

- Control points should be introduced to evaluate the status of major priority plan execution.

- Monthly checking and action

Cheking is made in relaton to the goal and major priority plan; action is taken with respect to the major priority plan.

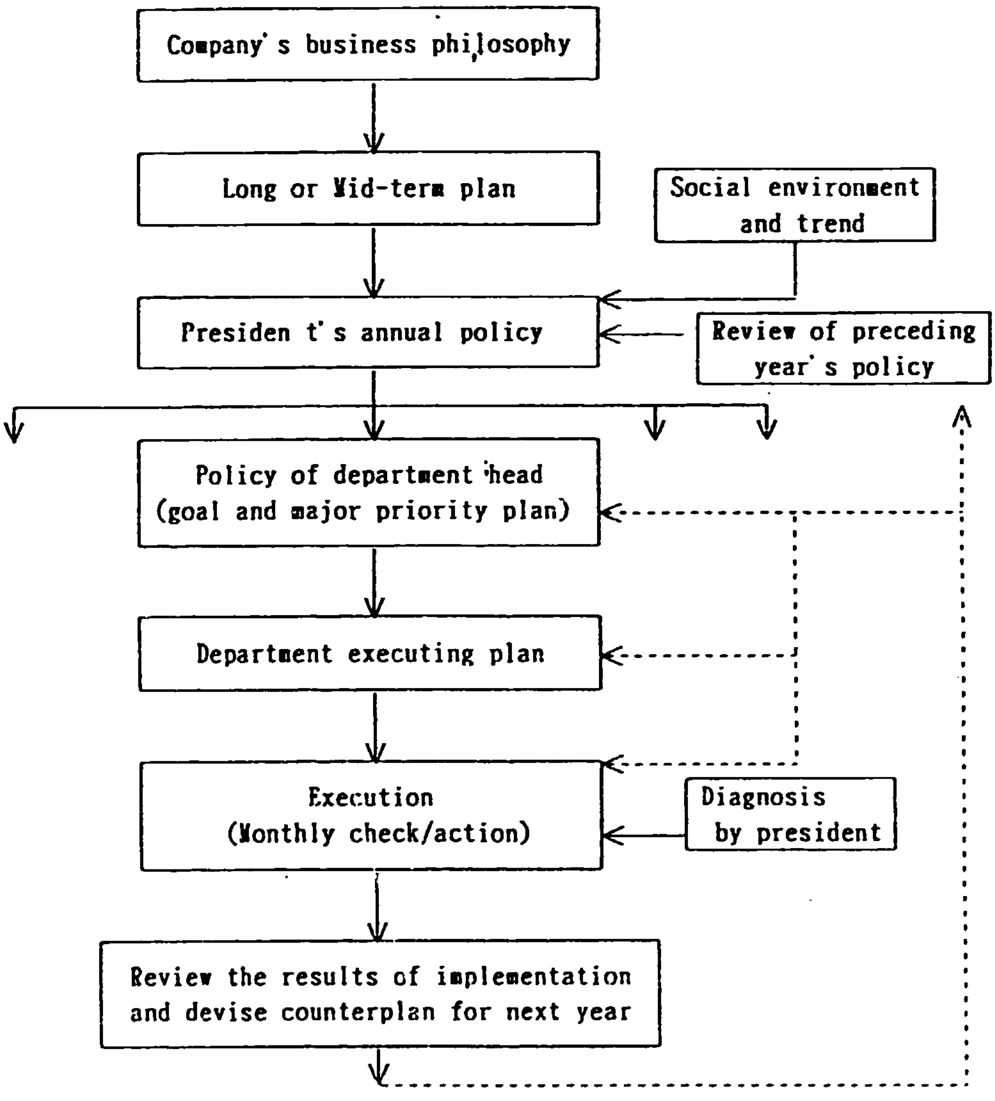


Figure 5.1 Example of the system of Policy Deployment

(2) Daily Management

- Daily management means activities conducted by each department every day in order to carry out their respective assigned roles.

- The control point stands as a measure to evaluate the progress being made by each department in achieving their specfic roles.

- Control points should be established as part of the process of daily management, and the plan-do-check-action (PDCA) cycle should be repeated on an ongoing basis.

- While policy deployment aims at drastic improvement, daily management focuses on maintaining the present level and on minor improvement.

(3) Cross-functional Management

- Generally corporate organization is classified according to departments. By contrast, cross-functional management purposes to control such operational aspects as quality, cost, delivery and safety (QCDS) from the companywide standpoint.

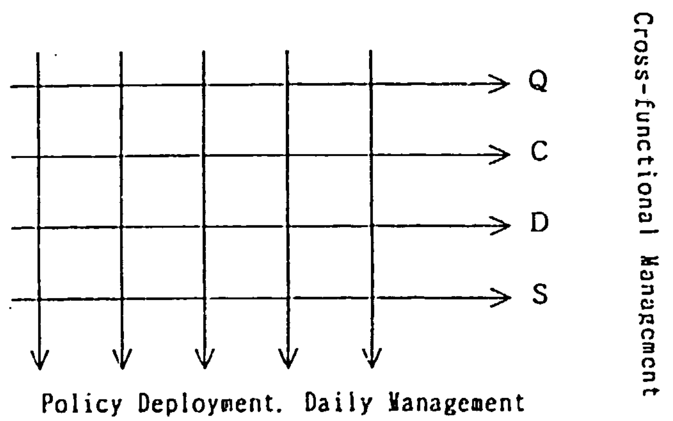


Figure 5.2 Concept of Cross-functional Management

(4) Quality Assurance System. New Product Development System. Complaint Handling System. Customer Satisfaction Survey System. etc.

(5) Staff Education and Training Plan

QC Circle system. Suggestion box systems. etc.

(6) QC Project Team

(7) Presidential Diagnosis

6. QC tools

A-Group (Statistical techniques)

QC 7 tools (Histogram. Stratification. Pareto diagram. Cause-and-Effect diagram. Check sheet. Graph. Scatter diagram)

Control Chart

Estimation and Testing Hypothesis

Design of Experiments

Regression Analysis

Multivariate Analysis

Quantification Theory

Sampling Inspection

Sensory Test

Taguchi's Method

Cp/Cpk Analysis

Weibull Analysis

Hazard Analysis

Accelerated life test

B-Group

Management 7 tools

(Affinity diagram. Relation diagram. Tree diagram. Matrix diagram. Matrix-Data Analysis. Process Decision Program Chart. Arrow diagram)

Quality Function Deployment (QFD)

Design Review (DR)

Failure Mode and Effect Analysis (FMEA)

Fault Tree Analysis (FTA)

QC Process Chart

QC story

2–WEEK TRAINING COURSE
FOR FCAV, BRAZIL
UNIDO PROJECT
(TF/BRA/92/B10, DP/BRA/92/004)

TOTAL QUALITY CONTROL
(SYNOPSIS)

Ichiro MIYAUCHI

COUNSELOR, J U S E

UNION OF JAPANESE SCIENTISTS AND ENGINEERS

UNION OF JAPANESE SCIENTISTS AND ENGINEERS
(NIPPON KAGAKU GIJUTSU RENMEI)
5–10–11, Sendagaya, Shibuya–ku, Tokyo 151, JAPAN

SECTION

1. GENERAL

- DOING RIGHT THING
  [quality assurance
  and
  standardization]

- DOING THING RIGHT
  [continuous
  improvement]

TQC_{JAPAN}

= (DR. DEMING)^{JAPAN}

(+)

(DR. JURAN)

(+)

(DR. FEIGEN-)

(BAUM)

= (STATISTICAL)^{JAPAN}

(QUALITY COTROL)

+

(QUALITY MANAGE-

(MENT)

+

(TQC$_{FEIGENBAUM}$)

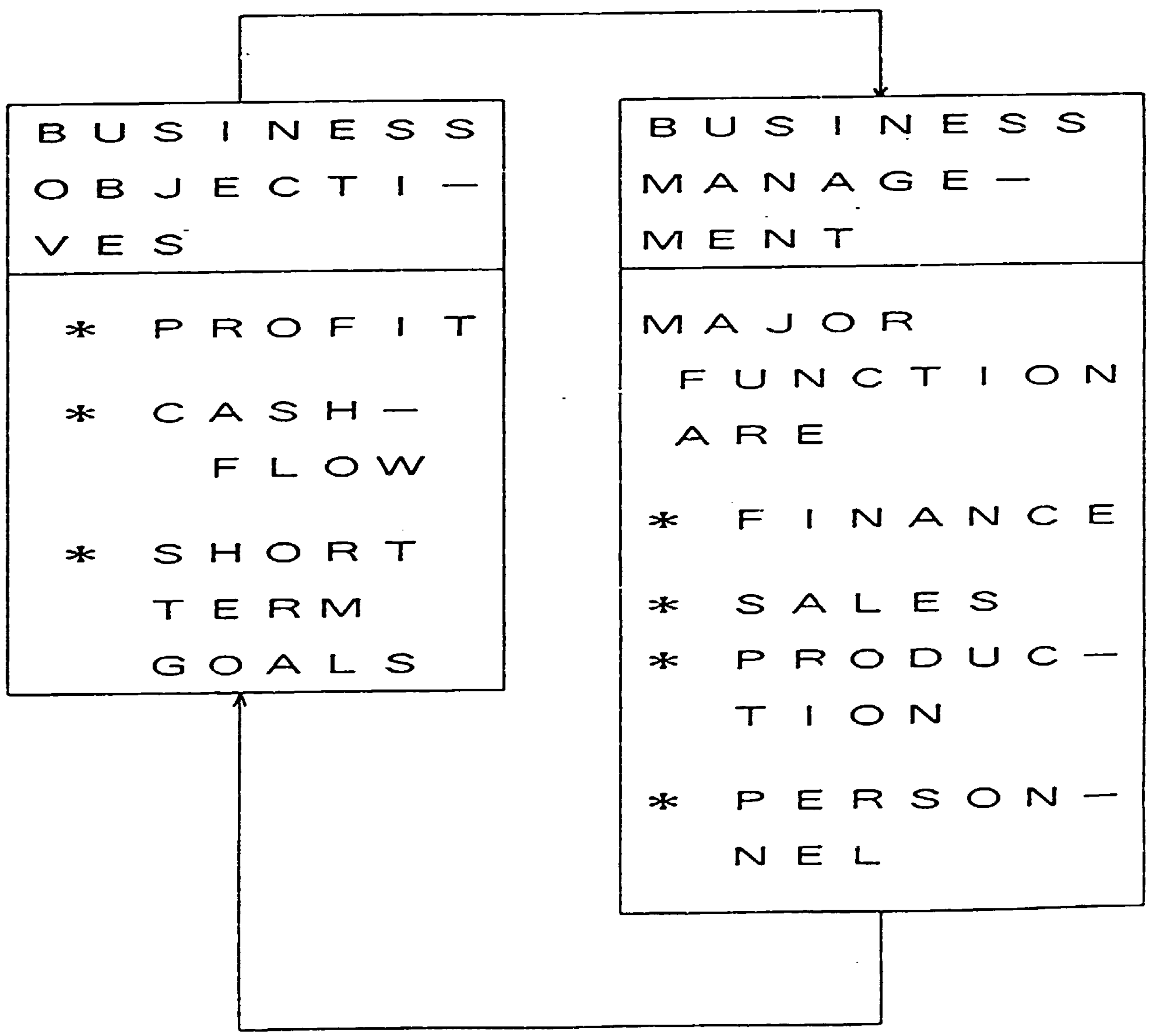
= COMPANY-WIDE QUALITY CONTROL (CWQC)

$$TQC_{JAPAN} = (TOTAL)^{JAPAN} (QUALITY)(CONTROL)$$

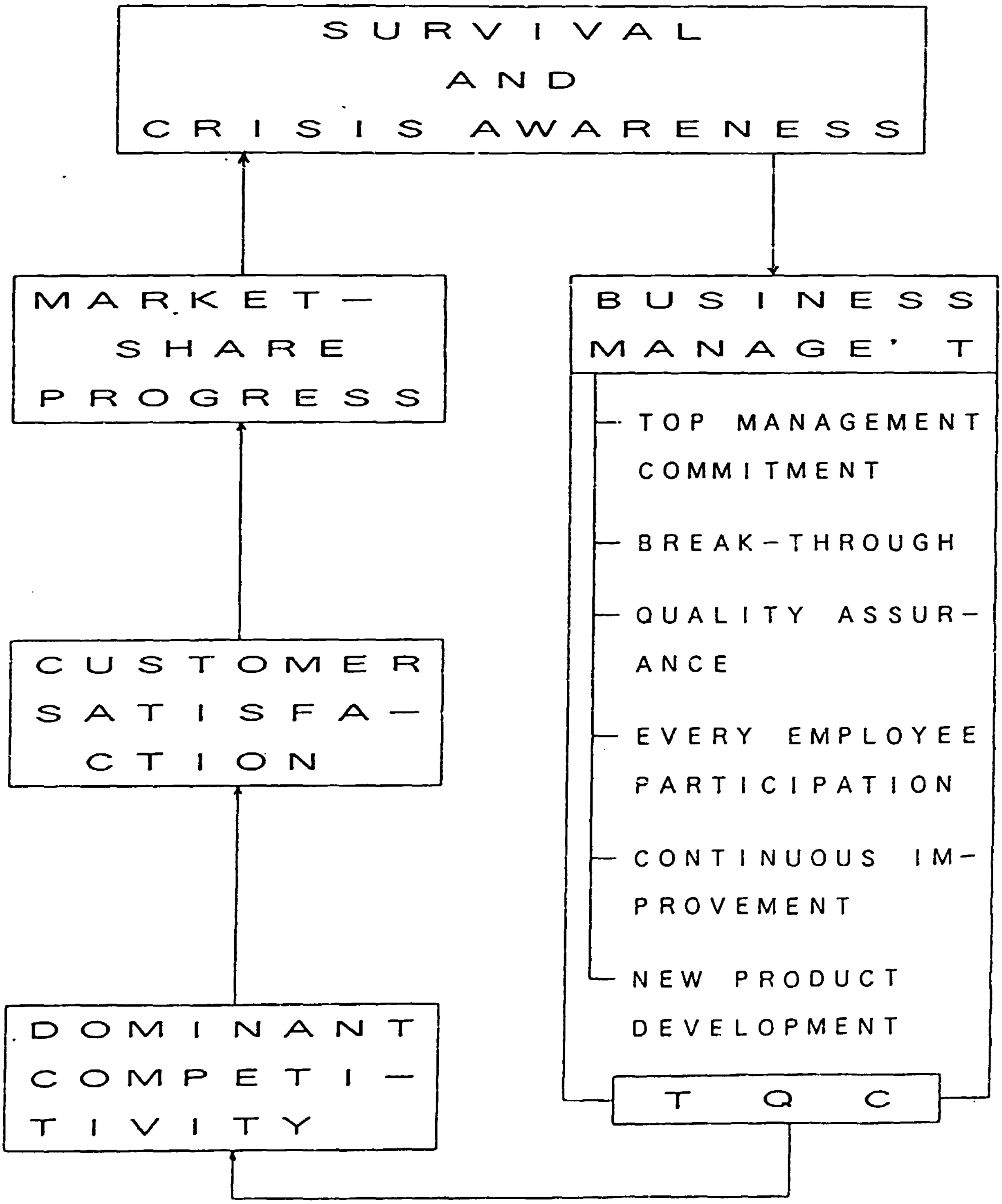
$$= TOTAL\,(QUALITY \times CONTROL)$$

$$= TOTAL\ QUALITY \times TOTAL\ CONTROL$$

CONVENTIONAL BUSINESS MANAGEMENT



TQC CONCEPTED BUSINESS MANAGEM' T



TOTAL QULITY

: HARDWARE QUALITY

SOFTWARE QUALITY

PROCESS QUALITY

HUMAN BEHAVIOR

DAILY ROUTINE

WORK QUALITY

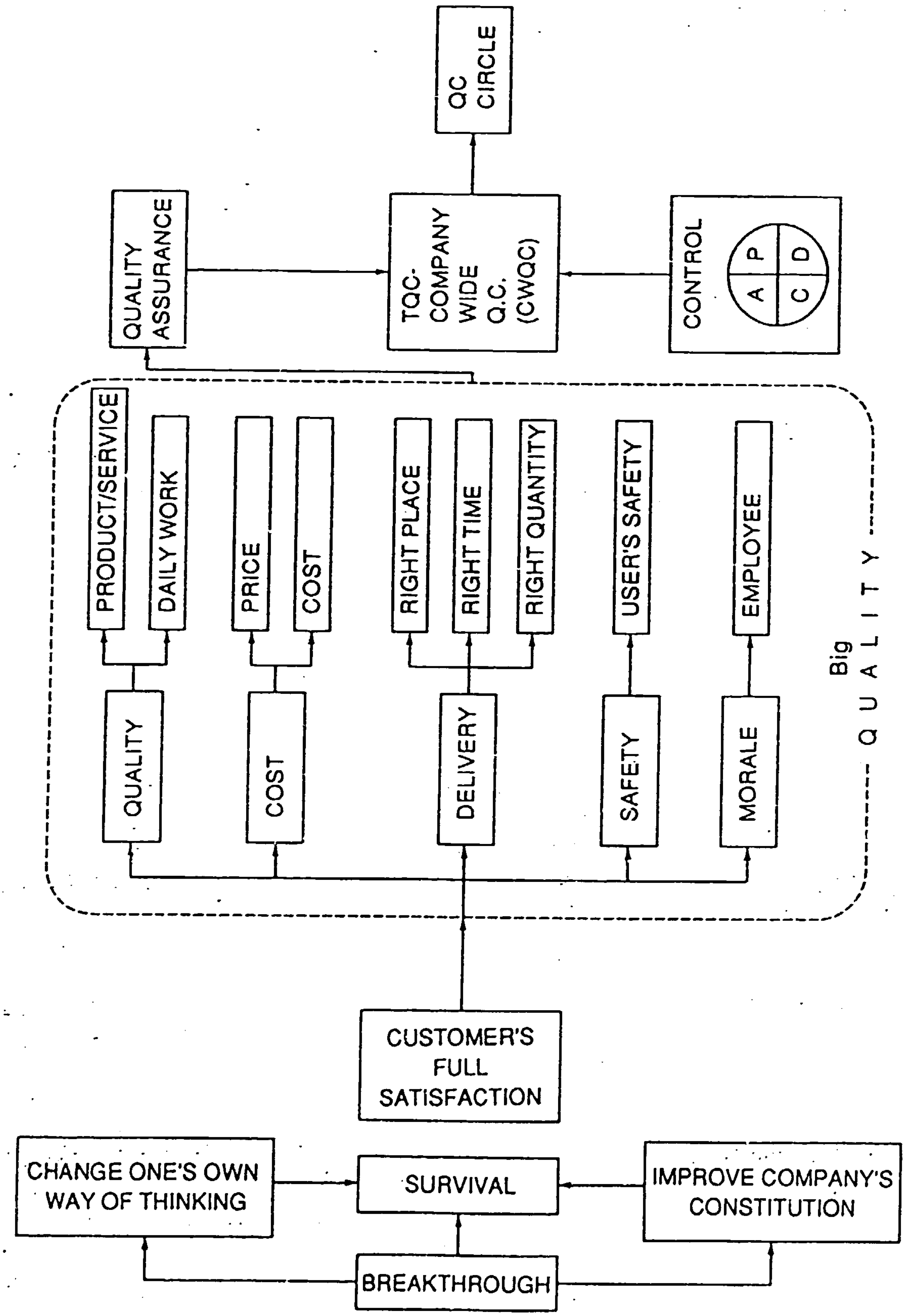
(ADMINISTRA-

TION, SEFVICE

FINANCE, PER-

SONNEL, CLER-

ICAL, ETC.)


QC CIRCLE
QUALITY ASSURANCE
TQC-COMPANY WIDE Q.C. (CWQC)
CONTROL
A P C D
PRODUCT/SERVICE
DAILY WORK
PRICE
COST
RIGHT PLACE
RIGHT TIME
RIGHT QUANTITY
USER'S SAFETY
EMPLOYEE
QUALITY
COST
DELIVERY
SAFETY
MORALE
Big QUALITY
CUSTOMER'S FULL SATISFACTION
CHANGE ONE'S OWN WAY OF THINKING
SURVIVAL
IMPROVE COMPANY'S CONSTITUTION
BREAKTHROUGH

Big "QUALITY"

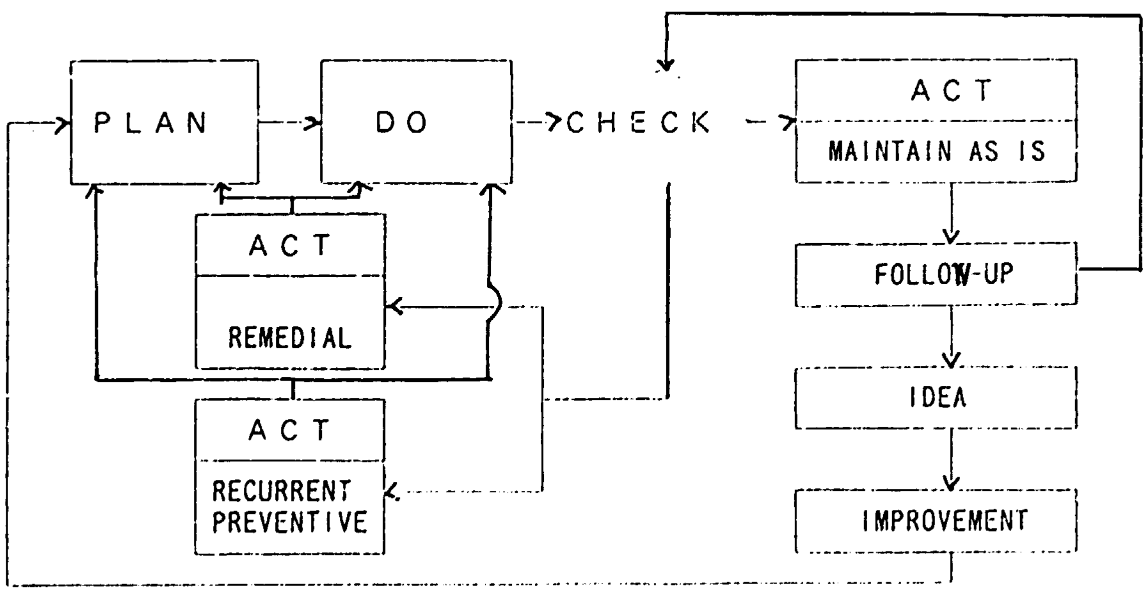
COMPANY — WIDE QUALITY

QUALITY	CHARACTERISTICS
TOP MANAGE-MENT	POLICY & OBJECTIVES DISSEM-INATION, SYSTEM & ORGANIZA-TION ESTABLISHMENT, PERSON ASSIGNMENT, INSTRUCTION, LEADERSHIP, COMMAND, HEALTH
COMPANY PERFOR-MANCE	PROFITABILITY, GROWTH RATE, DEVELOPABILITY, MARKET SHARE EXPANSION, COMPETITIVITY DO-MINANCY, NEW PRODUCT DEVELOP MENT, NEW TECHNOLOGY DEVELOP MENT,
PRODUCT/ SERVICE	PERFORMANCE, FUNCTION, RELI-ABILITY, MAINTENABILITY, SUS-TAINABILIT, SAFETY, EMPHATHY, TIMELINES, COURTEOUSNESS, CUSTOMER SATISFACTION CON-FORMANCE, CLAIM HANDLING
EMPLOYEES BEHAVIOR	MORALE AWARENESS, WORK-ETHIC SKILL LEVEL, EMPATHY & KIND-NESS AWARENESS, SPEAKING & WEARING MANNERS, PEOPLE-BUILD CONCEPT AWARENESS
WORK-SHOP ENVIRON-MENT	GOOD HOUSE-KEEPING STATUS, CLEANLINESS, HYGENIC STATUS, COMFORTABILITY, SAFETY ASSU-RANCE, GOOD MENU & DISHES, FREE-SPEAKING ATMOSPHERE
COMMUNITY CONTRIB'N	CULTURAL CONTRIBUTION, NON-POLLUTION PROBLEM (AIR, WATER ACOUSTIC, VIBRATION, ETC)
COMPANY IMAGE IN SOCIETY	ACCEPTANCE OF TOP MANAGEMENT BEHAVIOR, COMPANY'S REPUTA-TION, EMPLOYEES' REPUTATION, GENERAL ACCEPTANCE BY SOCIAL REPUTATION

TOTAL CONTROL

: PLAN — DO — CHECK — ACT

: CONTINUOUS IMPROVEMENT AND MAINTAINING WITHOUT FAILURE



QUALITY MANAGEMENT

DEFINITION:

THAT ASPECT OF THE OVERALL MANAGEMENT FUNCTION THAT DETERMINES AND IMPLEMENTS THE QUALITY POLICY.

(BY ISO 8402)

SECTION

2. TQC – GENERAL

PARAGRAPH

2.1

DEFINITION OF TQC

TQC IS

AN ACTION

TO PRODUCE AND

DELIVER

COMMODITY OR

SERVICE

WHICH ARE CONFORM-

ING TO CUSTOMERS

NEEDS OR REQUIREM'T

BY BETTER
CHEAPER
FASTER
SAFER
EASIER

PROCESSING THAN

COMPETITITORS

WITH PARTICIPATION

OF ALL EMPLOYEES BY

TOP MGT LEADERSHIP.

PARAGRAPH

2.2

TQC IMPLEMENTATION

BASIC STRUCTURE;

1. TOP MANAGEMENT COMMITMENT FOR;
   - SURVIVAL CONCEPT
   - CUSTOMER SATISFACTION
   - DOMINANT COMPETITIVITY
2. VISION & STRATEGY DISSEMINATION
   - LONG TERM
   - MEDIUM TERM
   - ANNUAL

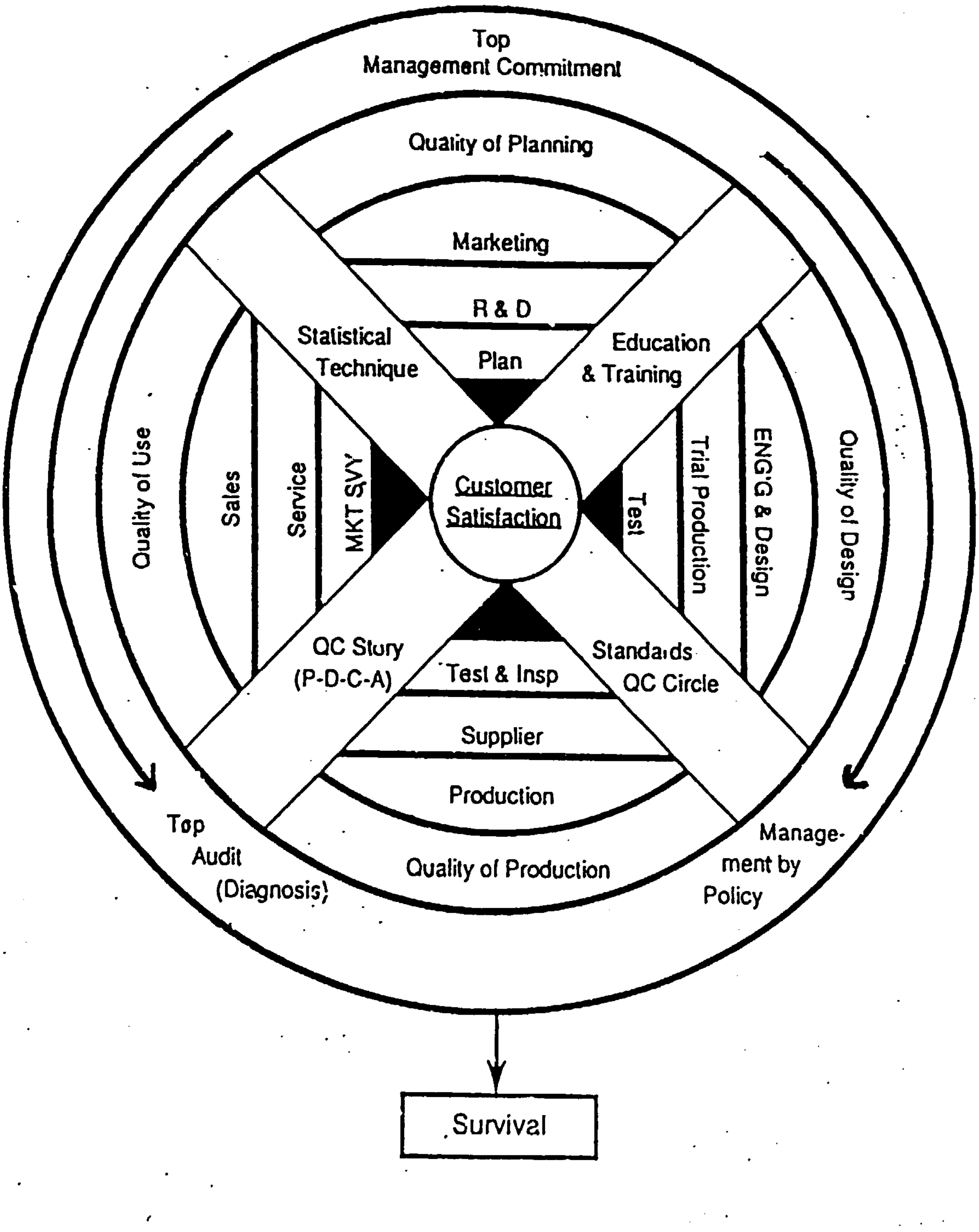
   POLICY AND OBJECTIVES

   WITH MEASUREABLE

   & VERIFIABLE ONES

3. STRUCTURE FOR;

- FUNCTIONAL ORGA-NIZATION
- AUTHORITY AND RE-SPONSIBILITY
- TQC STEERING COM-MITTEE & OFFICE
- ASSIGNEMENT OF QUALIFIED PER-SONNEL
- EDUACTION AND TRAINING PROGRAM FOR EVERY LEVELS


Top
Management Commitment
Quality of Planning
Marketing
R & D
Plan
Statistical Technique
Education & Training
Quality of Use
Sales
Service
MKT SVY
Customer Satisfaction
Test
Trial Production
ENG'G & Design
Quality of Design
QC Story (P-D-C-A)
Test & Insp
Standards QC Circle
Supplier
Production
Top Audit (Diagnosis)
Quality of Production
Management by Policy
Survival

PARAGRAPH
2.3

TQC IMPLEMENTATION ACTIONS

1. PREPARATION OF STANDARDIZATION

2. EXECUT'N OF MANAGEMENT BY POLICY

   - CROSS-FUNCTIONAL MANAGEMENT (POLICY AND OBJECTIVE DEPLOYMENT)

   - DAILY ROUTINE-WORK MANAGEMENT (CONTINUOUS IMPROVEMENT AND SUSTENANCE)

3. QUALITY ASSURANCE

   - FOR EXTERNAL & INTERNAL CUSTOMERS (ESTABLISHMENT OF CONTROL AND CHECK ITEMS)

4. QULITY AUDIT BY TOP & SENIOR MANAGEMENT, QUALITY ASSUREANCE AND TQC OFFICES

5. USE OF STATISTICAL METHODS

6. EXECUTION OF EDUCATION AND TRAINING

7. INSTALLATION OF QC CIRCLE ACTIVITY

8. CONSULTATION BY TQC OFFICE FACILITATORS

PARAGRAPH 2.4

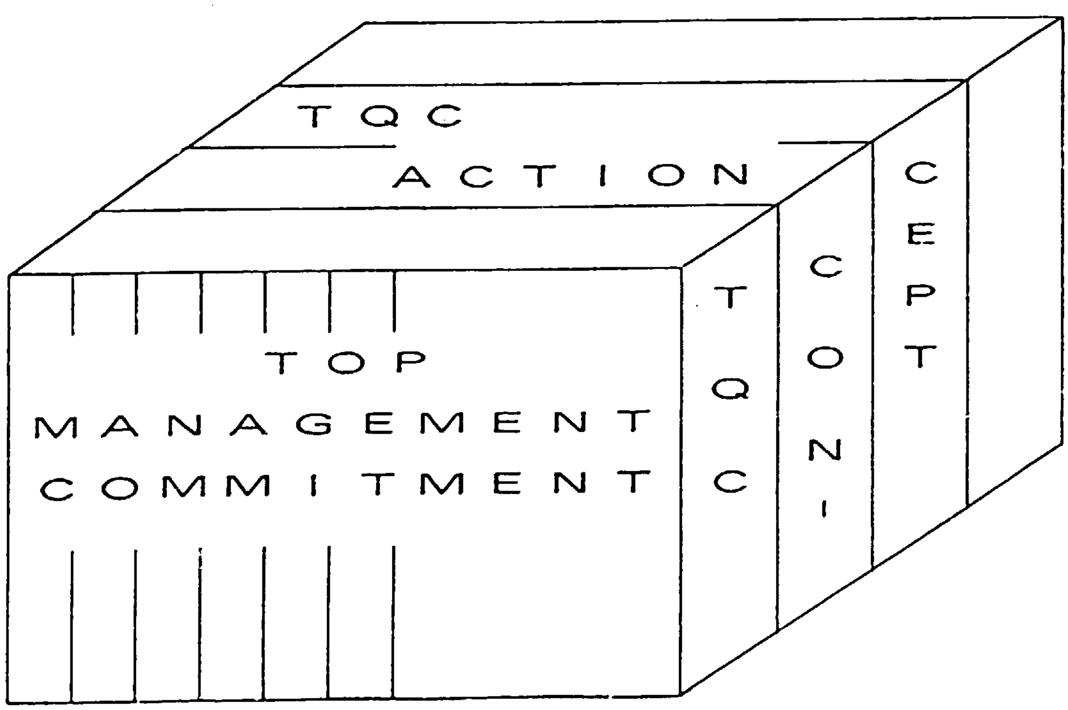
TQC CONCEPTS

1. "MARKET-IN" CONCEPT
2. NEXT DOWN STREAM SHOP IS CUSTOMER CONCEPT
3. "QUALITY FIRST" CONCEPT
4. UPPER STREAM PROCESS CONTROL CONCEPT
5. "FACT AND DATA" APPRECIATION CONCEPT
6. "VITAL FEW" CONCEPT
7. "DiSPERSION CONROL" CONCEPT
8. IN-PROCESS CONTROL CONCEPT

9. "RECURRENT FAILURE PREVENTIVE ACTION PRIORITY" CONCEPT

10. "PEOPLE BUILDING FIRST" CONCEPT

11. EMPLOYEES FULL PARTICIPATION OR INVOLVEMENT CONCEPT FOR TOP MANAGEMENT COMMITMENT



PARAGRAPH
2.4.1

<u>"MARKET-IN"</u> CONCEPT
(EMPATHY CONCEPT)

TO PRODUCE AND

TO SUPPLY

COMMODITY AND

SERVICES

WHICH ARE

DEFINITELY

REQUESTED BY

CUSTOMER.

<u>EMPATHY</u>:

TO TAKE ACTIONS

FOR ANY PERSONNEL

BY PUTTING YOURSELF

AT HIS POSITION OR

HIS CIRCUMSTANCES.

HOW TO DO

FOR "MARKET-IN"

1. TO INSTALL MARKET INFORMATION COLLECTING SYSTEM
2. TO IDENTIFY PRODUCT USE AND SERVICE ENVIRONMENT
3. TO MODERNIZE NEW PRODUCT & SERVICE DEVELOPMENTS
4. TO STRENGTHEN NEW TECHNOLOGY IMPLEMENTATION
5. TO PREVENT FROM ANY DEFECTS BY PREDICTING OR FORECASTING AT EARLIER PHASES

6. TO ESTABLISH FULL QUALITY ASSURANCE SYSTEM AND ORGANIZATION

7. TO PREPARE FOR A SMOOTH TRANSIT FROM PROTO-TYPE PRODUTION TO MASS STAGE

8. TO CONTINUOUSLY IMPROVE EVERY IN-PROCESSES AT PRODUCTION AND SERVICE STAGES UNDER CUSTOMER SATISFACTION CONCEPT.

9. TO SCIENTIFICAL-
LY AND SYSTEMATI-
CALLY SOLVE ANY
PROBLEMS AT EVERY
STAGES BY STATIS-
TICAL ANALYSIS
METHODS

10. TO ESTABLISH SER-
VISING NET-WORKS
FOR CUSTOMER SAT-
ISFACTION

PARAGRAPH 2.4.2

"NEXT DOWN STREAM SHOP IS CUSTOMER" CONCEPT

- TREAT YOUR DOWN-STREAM SHOP IS YOUR CUSTOMER WHO IS A KING OR QUEEN, THAT DON'T ARGUE WITH BUT FOLLOW WHATEVER THEY WANT IF ONLY IT IS REASONABLE

- DON'T SEND ANY DE-FECTIVE OR WRONG PRODUCT OR SERVICE TO YOUR DOWN-STREAM SHOP

HOW TO IMPLEMENT "NEXT DOWN STREAM SHOP IS CUSTOMER" CONCEPT

1. TO IDENTIFY WHO IS YOUR CUSTOMER

2. TO STUDY WHAT KIND OF WORKS ARE OPERATING AT NEXT DOWN STREAM SHOP AND HOW YOUR QUALITY ARE CONTRIBUTING TO THEIR QUALITY INTEGRATION

3. TO CLARIFY WHICH QUALITY CHRACTERISTICS ARE IMPORTANT OR CRITICAL TO DOWN STREAM SHOP

4. TO ESTABLISH FIRM WRITTEN PROCEDURE TO ASSURE SUCH CUSTOMER REQUESTED QUALITY FOR DOWN STREAM SHOP

5. TO ESTABLISH FOR ELIMINATING OR IM-ROVING PROGRAM FOR ANY DETRIMENT-AL OPERATIONS IN OWN SHOP TO CUSTO-MER

6. TO ESTABLISH OWN'S DEFINITE CRITERIA FOR DECISION FOR YOUR CUSTOMER UNDER SELF-CON-ROLLING AWARENESS

7. TO CONDUCT SELF-INSPECTION FOR DOWN STREAM SHOP BY SELF-QULITY AWARENESS

PARAGRAPH
2.4.3

HOW TO IMPLEMENT "QUALITY FIRST"

1. TO IDENTIFY QUALITY WHICH ARE LOCATED AS HIDDEN, POSSIBLE, POTENTIAL OR REVEALED CUSTOMERS NEEDS OR REQUIREMENTS IN MARKETS
2. TO DEFINE QUALITY AT PLANNING STAGE WHERE IS PREDICTING OR FORECASTING FOR NEXT 5 -- 10 YEARS CUSTOMER REQUIREMENTS AND STILL FAR BETTER THAN COMPETITORS

3. TO DESIGN QUALITY AT DESIGN STAGE WHERE IS TRANS-LATING AND INTER-PRETTING THOSE CUSTOMERS NEEDS OR REQUIREMENTS INTO MATERIALIZ-ED AND PRODUCIBLE WRITTEN DOCUMENT-ATIONS CALLED AS SPECIFICATIONS AND DRAWINGS

4. TO ASSURE QUALITY AT EVERY PRODUCT-ION STAGES, WHERE ARE CONFORMING WITH SPECIFIC DO-CUMENTATIONS, SOP

5. TO ASSURE QUALITY AT USING STAGE, WHERE ARE SUPPLY-ING FEASIBLE AND UNDERSTANDABLE OPERATION MANUAL, AND MAINTENANCE & REPAIRING HAND BOOKS, TO FURNISH BETTER CUSTOMER AFTER-SERVICES THAN COMPETITORS, AND TO SWIFTLY, AND SATIFACTORILY RESPOND ANY CLAIM AND COMPLAINT BY CUSTOMERS WITH EMPATHY CONCEPT

PARAGRAPH
2.4.4

"UPPER STREAM CONTROL" CONCEPT

QUALITY OF CUSTOMER SATISFACTION ARE EXCLUSIVELY RELYING UPON UPPPER STREAM QUALITY DECISION SUCH AS MARKETING, PLANNING, R & D, AND ENGINEERING

90 % OF PRODUCT QUALITY ARE DETERMINED AT DESIGN PHASE, AND ONLY 10 % OF IT ARE RESPONSIBLE BY PRODUCTION, INSPECTION OR SERVICE

HOW TO IMPLEMENT "UPPER STREAM CONTROL" CONCEPT

1. TO ESTABLISH NEW PRODUCT DEVELOPMENT SYSTEM AND IT ITS QUALITY ASSURANCE SYSTEM WHICH ARE COVERING FROM MARKETING THROUGH ENGINEEERING TO SALES AND SERVICE ORGANIZATIONS

2. TO IDENTIFY CUSTOMERS NEEDS AND REQUIREMENT BY QUALITY DEPLOYMENT METHOD

3. TO ASSURE QUALITY AT EVERY STAGES OR PHASES BY RESPONSIBLE ORGANIZATIONS AND IF FOUND NOT ASSURED, NEVER SEND TO THE NEXT

5. TO FORECAST, PRE-
DICT, OR SIMULATE
ANY POSSIBLE, OR
POTENTIAL FAILURE
WHICH MIGHT BE OB-
SERVABLE AR SUC-
CEEDING STAGES,
AND
TO TAKE PREVEN-
TIVE ACTIONS AT
PLANNING, DESIGN,
PROTO-TYPE PRO-
DUCTION & TEST, OR
PRE-PRODUCTION
STAGES.

6. TO INVESTIGATE AND
AND ESTABLISH COR-
RECTIVE ACTION
WHEN SOME TROUBLE
BE HAPPENED AT
SUCCEEDING STAGES
FOR WHY NOT BE PRE-
DICTABLE OR FORE-
SEENABLE AT UPPER
STREAM QUALITY
ASSURANCE ACTIVI-
TIES

7. TO PREPARE FOR STANDARDS TO SUSTAIN CONSISTENT QUALITY BY SUCH AS REGULATIONS, TECHNICAL STANDARDS, FLOW CHARTS, CHECK SHEET, STANDARD OPERATION PROCEDURES, OFFICE INSTRUCTIONS, ETC

PARAGRAPH
2.4.5

"FACT & DATA APPRECIATION CONCEPT

TO SPEAK
TO CONSIDER AND
TO TAKE ACTION
WITH DATA BASED
ON FACT

DON'T ACCEPT ANY
REPORTS WITHOUT
JUSTIFYING DATA
OR FACT

DON'T SUBMIT ANY
REPORTS WITHOUT
JUSTIFYING DATA
OR FACT

IF IT IS, IT COULD BE FICTION.

HOW TO IMPLEMENT "FACT AND DATA APPRECIATION" CONCEPT

1. TO PHYSICALLY AND PERSONALLY VISIT A PROJECTING OR PROBLEM SOLVING SITE TO VERIFY OR OBSERVE FACT AND DATA COLLECTION

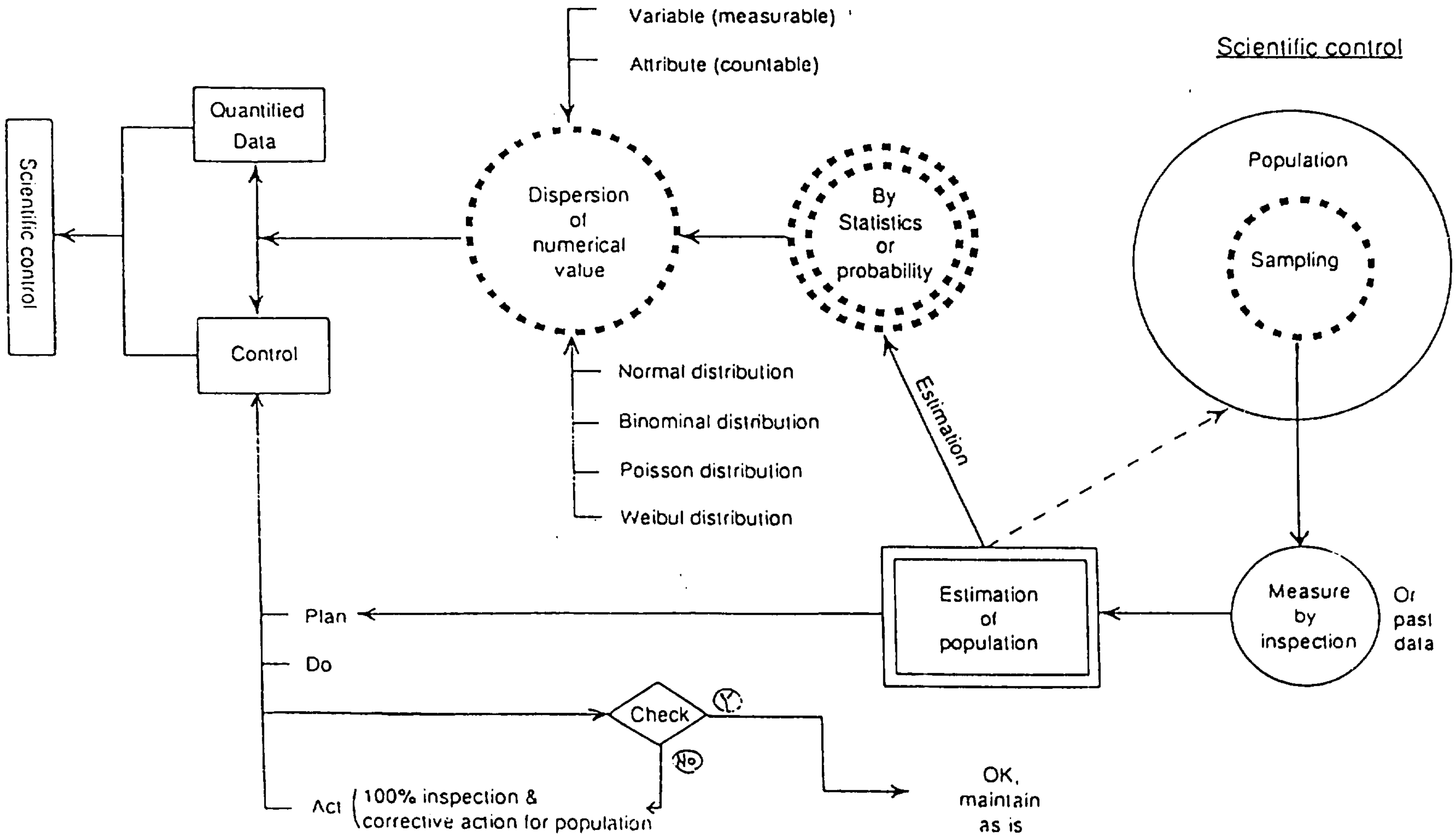
2. TO DETERMINE WHICH QUALITY CHARACTERISTICS ARE NECESSARY TO IMPROVE/ CORRECT AFTER STUDYING THEIR PRESENT STATUS

3. TO COLLECT DATA AS SPECIFIED

4. TO ANALYZE DATA COLLECTED BY STATISTICAL METHODS

5. TO SUMMARIZE AND EVALUATE THE RESULTS OBTAINED AND PREPARE REPORTS AS RELIABLE AND RIGHT INFORMATIONS UNDER THOROUGH CONSIDERATIONS

Data Source



Scientific control
Variable (measurable)
Attribute (countable)
Quantified Data
Scientific control
Dispersion of numerical value
By Statistics or probability
Population
Sampling
Control
Normal distribution
Binominal distribution
Poisson distribution
Weibul distribution
Estimation
Estimation of population
Measure by inspection
Or past data
Plan
Do
Check
Y
No
OK, maintain as is
Act
100% inspection & corrective action for population

PARAGRAPH
2.4.6

"VITAL FEW" CONCEPT

NOT TRIVIAL MANY,
BUT "VITAL FEW"

TO IDENTIFY THE
MOST CRITICAL OR UN-
DESIRABLE PROBLEMS
IN EVERY WORK-SHOPS
AND
TO SOLVE SUCH ONE
WITH JUSTIFICATION
AND STILL CONFORM-
ING TO TOP MANAGE-
MENT COMMITMENT,
WHICH ARE EXPLAINED
BY FACT AND DATA
UNDER THE HIGHEST
PRIORITY

HOW TO IMPLEMENT "VITAL-FEW" CONCEPT

1. TO IDENTIFY OWN'S PRESENT STATUS AT WORKSHOP
   WHILE REVEALING WEAKNESS AND ST-RENGTH
   COMPARING WITH COMPETITORS
   BY SHAKE-DOWN WITH SUBORDINATES

2. TO ESTABLISH OWN BENCH MARKS FOR BETTERMENT
   ON THE SUBJECTS TO BE NECESSARY TO IMPROVE

3. TO PRIORITIZE THE CRITICAL OR UNDESIRABLE PROBLEMS ON PERFORMANCES, FUNCTIONS, RELIABILITY, SAFETY, PRICE, DEVELOPING DURATION, ETC.,

FIRSTLY,

FOR REACHING THE BENCH MARKS ESTABLISHED, AND

SECONDLY,

FOR DEVELOPING TO MUCH BETTER OBJECTIVES THAN COMPETITORS ONES

4. TO DISCUSS AND CONFER WITH TOP OR SENIOR MANAGEMENT IF PROBLEMS IDENTIFIED ARE MEETING WITH THEIR POLICY AND OBJECTIVES

5. FINALIZE THE GOAL WITH QUANTIFIED INDEX AND PROGRAM TO BE FOLLOWED BY SPECIFIC DATE

PARAGRAPH
2.4.7

"DISPERSION CONTROL" CONCEPT

ANY DATA HAVE TEN-DENCIES TO VARIATE OR DISPERSE

IT IS NECESSARY TO WATCH SUCH DATA DISPERSION CARE-FULLY BY STATISTI-CAL METHODS, AND TO ANALYZE ITS ROOT-CAUSE ISOLATION FOR ESTABLISHMENT OF CORRECTIVE ACT-ION

HOW TO IMPLEMENT "DISPERSION CONTROL" CONCEPT

1. TO CAREFULLY INTERPRET AND EVALUATE FOR
   (A) SHAPE OF DISTRIBUTION
   (B) AVERAGE VALUE OF DISTRIBUTION ($\bar{X}$)
   (C) VARIATION OF DISTRIBUTION (σ)

2. TO STUDY AND IDENTIFY, WHY DISPERSION ARE HAPPENED IF CAUSED BY;
   (A) CHANCE CAUSE
   (B) ASSIGNEABLE CAUSE

3. IF IT IS CAUSED BY "CHANCE CAUSE", IT COULD BE DIS-REGARDED FOR FUR-THER ANALYSIS

4. IF CAUSED BY "ASSIGNEABLE", IT IS NECESSARY TO FURTHER ANA-LYZE FOR ISOLA-TION OF ROOT-CAUSE(S) TO ESTABLISH ANY CORRECTIVE ACTIONS FOR PREVENTION OF RECURRENT PROBLEM(S)

PARAGRAPH
2.4.8

" INPROCESS CONTROL "

CONCEPT

SO FAR ANY PRODUCT
QUALITY ARE INTE-
GRATED INTO PRODUCT
DURING EVERY INDI-
VIDUAL PROCESSING
WORK THAT INSPEC-
TION FOR FINISHED
ONES ARE TOO LATE TO
ASSURE ITS QUALITY.
AND
TOO LATE TO TAKE ANY
CORRECTIVE ACTIONS.

ANY WORK MUST BE
CONTROLLED
NOT BY RESULT
BUT BT INPROCESSES

HOW TO IMPLEMENT "INPROCESS CONTROL" CONCEPT

1. TO PREDICT ANY PROBABLE, POTENTIAL, OR HIDDEN PROBLEMS AT PRE- AND MASS PRODUCTION STAGES BY:

   A) QUALITY DEPLOYMENT (QUALITY FUNCTION DEPLOYMENT) METHOD

   B) FAILURE MODE EFFECT ANALYSIS METHOD

   C) FAULT TREE ANALYSIS METHOD

   D) HAZARD ANALYSIS METHOD

   E) DESIGN REVIEW BOARD SYSTEM

   F) PROCESS REVIEW BOARD SYSTEM

   G) SAFETY REVIEW BOARD SYSTEM (INCLUDED PRODUCT LIABILITY PREVENTION PROGRAM)

   BY DESIGN ENGINEERS

2. TO PREDICT PROBABABLE, POTENTIAL OR HIDDEN PROBLEM AT MASS PRODUCTION STAGE, BY;

A) QUALITY FUNCTION DEPLOYMENT METHOD

B) FAILURE MODE EFFECT ANALYSIS METHOD

C) QUALITY ASSURANCE SYSTEM FLOW CHART ANALYSIS METHOD

D) QUALITY CONTROL PROCESS CHART

BY PROCESS DESIGN ENGINEERS

3. TO STUDY, PREDICT OR FORECAST FOR FORESEENABLE USE OR MISUSE AND UNFORESEENABLE USE OR MISUSE AT CUSTOMERS USE-STAGE BY;

A) QUALITY DEPLOYMENT (QULITY FUNCTION DEPLOYMENT) METHOD

B) FAILURE MODE EFFECT ANALYSIS METHOD

C) FAULT TREE ANALYSIS METHOD

D) HAZARD ANALYSIS METHOD

E) DESIGN REVIEW BOARD SYSTEM

F) PROCESS REVIEW BOARD SYSTEM

G) SAFETY REVIEW BOARD SYSTEM (INCLUDED PRODUCT LIABILITY PREVENTION PROGRAM)

BY DESIGN ENGINEERS

4. TO EVALUATE DESIGN QUALITY ASSURANCE METHODS BY COMPARING WITH,

A) COMPETITORS STATUS FOR NEW OR CONVENTIONAL PRODUCTS

B) LITIGATED VERDICTS IN PRODUCT LIABILITY FOR SIMILAR PRODUCTS

C) CUSTOMER ACCEPTANCES FOR PAST CALIMS, OR COMPLAINTS HANDLINGS

5. TO EVALUATE PRODUCTION QUALITY ASSURANCE METHOD AND PRACTICES, BY COMPARING WITH ;

A) COMPETITORS STATUS FOR NEW OR CONVENTIONAL PRODUCTS AND PROCESSES

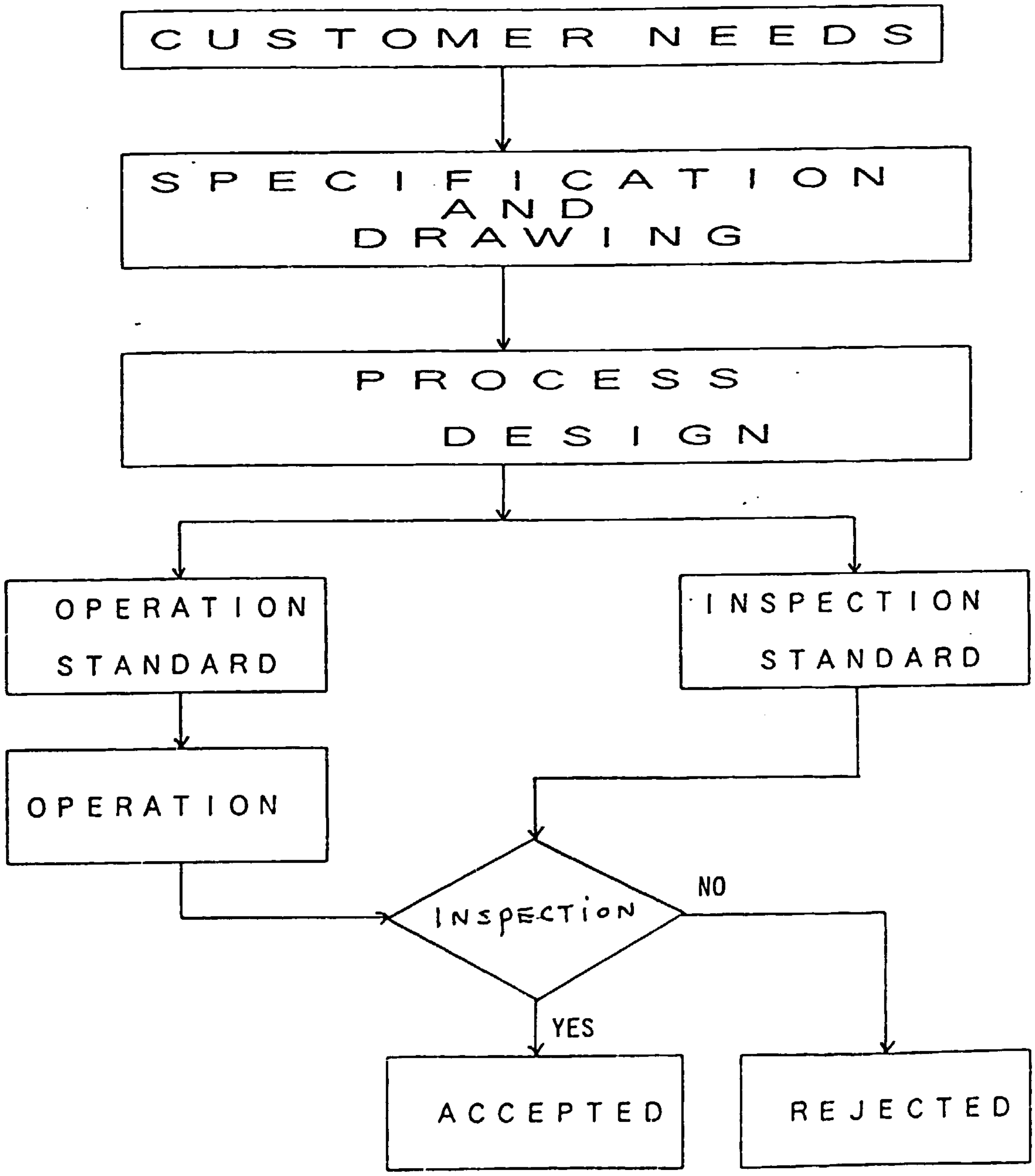
B) LITIGATED VERDICTS IN PRODUCT LIABILITY FOR SIMILAR PRODUCTS OR PROCESSES

C) CUSTOMER ACCEPTANCE FOR PAST CLAIM, OR COMPLAINT HANDLING

6. TO EVALUATE SERVICE QUALITY ASSURANCE SYSTEM AND PRACTICES BY COMPARING WITH ;

A) TO C) ACTIONS ARE NECESSARY TO FOLLOW AS SAME PROCEDURES AS EXPLAINED IN THE PRECEDING PARAGRAPH.

CONVENTIONAL "INSPECTION" CONCEPT



PARAGRAPH
2.4.9

"REPETIVE MISHAPS PREVENTIVE ACTION" CONCEPT

DON'T MAKE ANY SAME MISTAKE

DON'T PERMIT SAME MISTAKE OR ERROR

TO ESTABLISH POSITIVE RECURRENT PREVENTIVE ACTION FOR NEVER HAPPENING AGAIN BY SAME CAUSE

HOW TO IMPLEMENT "REPETIVE MISHAP PREVENTIVE ACTION" CONCEPT

1. TO ESTABLISH SOP FOR EVERY INDIVIDUALS SPECIFIC WORKS
2. TO EDUCATE & TRAIN AND TO HAVE FAMILIAR WITH THEM
3. TO IMPOSE MORE ADDED-VALUE WORK TO EVERY INDIVIDUALS BY MANAGEMENT
4. TO DELEGATE WORKS AFTER CERTIFICATION AS POSSIBLE AS CAN DEPENDING ON THEIR CAPABILITY

5. TO ASK THEIR CREA-
TIVITY FOR SUSTE-
NANCE AND IMPROVE-
MENT OF THEIR DAI-
LY ROUTINE WORK

6. TO ESTABLISH EMP-
LOYEES CAREER DE-
VELOPMENT PROGRAM
UNDER PEOPLE-
BUILDING PHYLOSO-
PHY

"RESPECT EMPLOYEE AS HUMAN-BEING" CONCEPT

TO RESPECT EVERY EMPLOYEES AS INDEPENDENT HUMAN-BEING

- TREAT THEM AS PARTNER
- TREAT THEM WITH DIGNITY
- TREAT THEM AS ADULT
- TREAT THEM WITH RESPECT

PARAGRAPH 2.4.10

HOW TO IMPLEMENT "RESPECT EMPLOYEES AS HUMAN-BEING" CONCEPT

1. TO UNDERSTAND MR. A. H. MASLOW'S HIER-ARCHY PRINCIPLES AND Y-ASSUMPTION OF MR. D. MC'GREGOR

2. TO UNDERSTAND BE-HAVIOR SCIENCE CONCEPTS
   - PROVIDE TASK VARIEY TO AVOID BOREDOM
   - ENLARGE THE JOB TO MEET THE SKILLS AND ABILITY OR WORKERS
   - PROVIDE FEED BACK ON PERFOR-MANCES
   - PROVIDE JOB CLOSURE OR JOB IENDIFICATION
   - SELF-CONTROL OF SIGNIFICANT ASPECT OF THE WORK
   - OPPORTUNITY TO LEARN NEW SKILLS
   - PARTICIPATION IN PROBLEM SOL-VING, PLANNING AND CONTROLLING

3. TO ESTABLISH CA-
REER DEVELOPMENT
PROGRAM FOR EVERY
EMPLOYEES

4. TO DEVELOP FOR ED-
UCATION AND TRAIN-
ING SCHEME TO COM-
PLY WITH

5. TO MOTIVATE AND
CHALLENGE EMPLOY-
EES FOR FOSTERING
SELF-STUDYING AND
PARTICIPATING EN-
VIRONMENT AND CIR-
CUMSTANCE WITHIN
EVERY WORKSHOPS

6. TO ORGANIZE FOR
QC CIRCLE IMPLE-
MENTATION PROGRAM
BY FLOOR PEOPLE

7. TO IMPLEMENT EDU-
CATION AND TRAIN-
ING PROGRAM

8. TO HAVE THEM INST-
ALL QC CIRCLE AT
OWN WODKSHOPS

PARAGRAPH 2.4.11

"TOP MANAGEMENT COMMITMENT UNDERSTANDING" CONCEPT

TO FOLLOW THE TOP MANAGEMENT'S CREED, VISION STRATEGY AND MISSION STATEMENT BASED ON SURVIVAL DOMINANT COMPETITIVITY AND CUSTOMERS FULL SATISFACTIONS AND TO EXECUTE POLICY AND GOAL DEPLOYED BY THE TOP TO EVERY MANAGEMENT

HOW TO IMPLEMENT "TOP MANAGEMENT COMMITMENT UNDERSTANDING" CONCEPT

1. TO UNDERSTAND CO'S CREED

2. TO UNDERSTAND TOP MANAGEMENT VISION AND STRATEGY HOW TO PARTICIPATE AND SHARE WITH FOR ACHIEVEMENT

3. TO UNDERSTAND C0'S MISSION STATEMENT FOR SHARING WITH SOCIETY CONTRIBU– TION RESPONSIBI– LITY

4. TO UNDERSTAND LONG AND MEDIUM TERM POLICY AND GOAL FOR PARTICI– PATING WITH SUR– VIVAL AND COMPETI- TIVITY DOMINANCY

5. TO FOLLOW ANNUAL POLICY AND GOAL DEPLOYED BY THE TOP MANAGEMENT TO EVERY SUBORDINATE MANAGEMENT

6. TO IMPLEMENT FOR CONTINUOUS IMPRO-VEMENT AND SUSTE-NANCE ACTION AT OWN ASSIGNED ORG-ANIZATIONS UNDER TOP MANAGEMENT FIRM COMMITMENT FOR DOMINANT COM-PETITIVITY ESTA-BLISHMENT

7. TO ENCOURAGE SUB-ORDINATES FOR IN-STALLATION OF QC CIRCLE ACTIVITY WITHIN ORGANIZA-TION

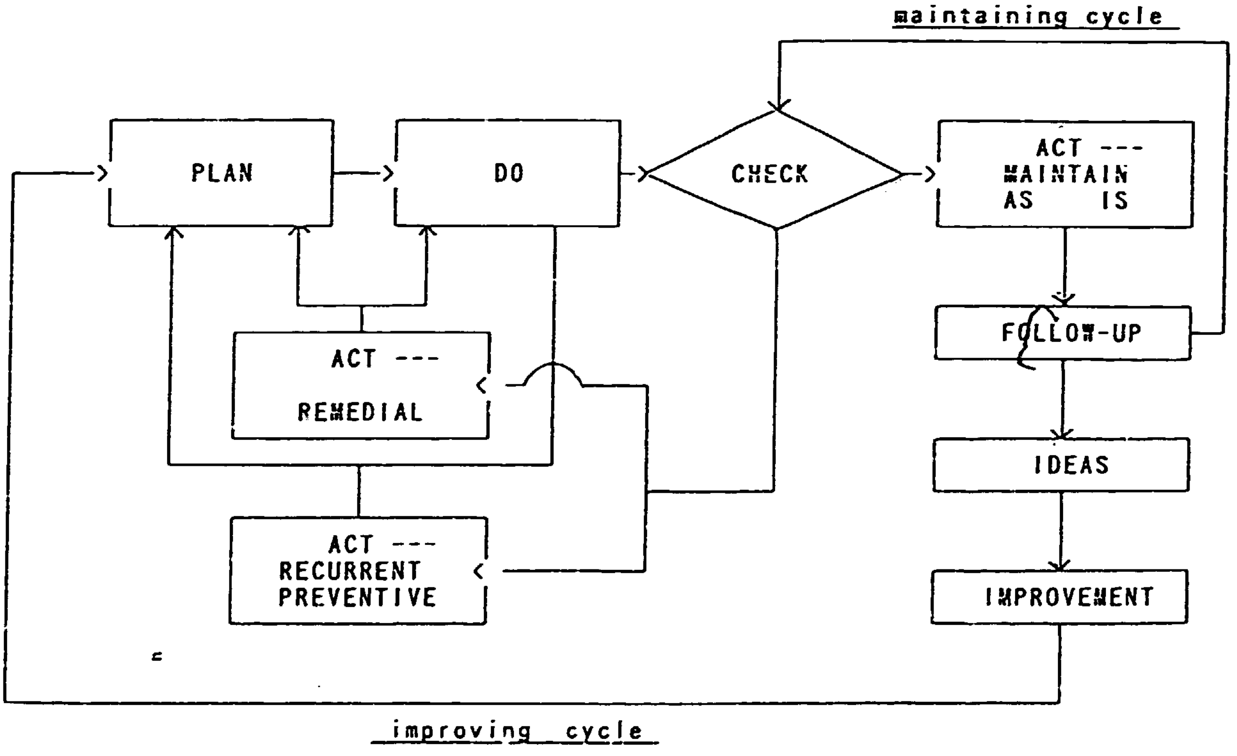
8. TO CAHLLENGE AND MOTIVATE FOR PEO-PLE-BUILDING CON-CEPT IMPLEMENTING

QC STORY
(P D C A)

-- A PROJECT/SCHEME IS HIGHLY RECOMMENDED TO FOLLOW PLAN-DO-CHECK-ACT CYCLIC PROCEDURE WHICH IS CALLED " QC STORY " IN JAPAN

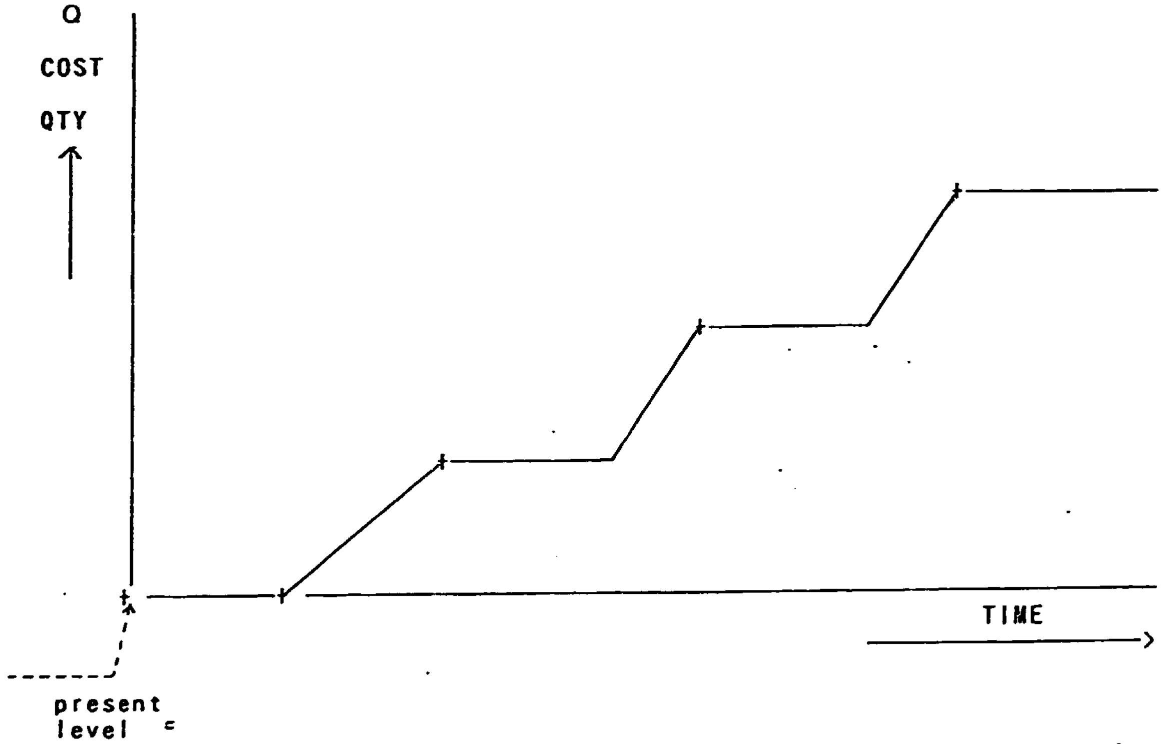
-- P L A N - D O - C H E C K - A C T CYCLE ! ORGANIZED AS SHOWN IN THE LEFT CHARTS TO CONTINUALLY ROLLING OR SPIRALLING UP TO SUSTAINING STATUS IN QUO AND IMPROVING STATUS IN QUO

-- SUCH FLOW-CHART IS ALSO SHOWN IN THE FOLLOWINGS;



-- WHEN IMPLEMENTING P-D-C-A CYCLIC ACTION, IT IS BASICALLY UTILIZED FOR IMPROVING PROGRAM THAT P-D-C-A ACTION IS NECESSARY TO BEGIN WITH CHECK-ACT-PLAN-DO CYCLIC ACTION WHICH MEANS TO COLLECT FACT/DATA FIRST, AND IDENTIFY PRESENT STATUS FOR IMPROVING NECESSITY DETERMINATION.

-- ONCE SUCH IMPROVING PROGRAM IS SUCCEEDED, IT IS NECESSARY TO SUSTAIN THIS PROGRAM THAT P-D-C-A IS CHANGE TO S(STANDARD)-D-C-A CYCLIC ACTION AS SHOWN IN THE FOLLOWING DIAGRAM



RECURRENT PREVENTIVE ACTION

-- THE BASIC CONCEPT IS TO ESTABLISH A ACTION FOR " NOT MAKE ANY SAME MISTAKE "

OR " NOT PROBLEM HAPPENED BY SAME CAUSE "

-- THE MOST RESPONSIBILITY FOR REPETIVE PROBLEL ARE LAID AT ENGINEERING - TECHNICAL DESIGN c PROCESS DESIGN ORGANIZATIONS`

-- TECHNICAL DESIGN ENGINEERINGS ARE NECESSARY TO COMPLY WITH INTRINSIC ENGINEERING PRINCI-PLE AND TO GUARANTEE THEIR QUALITY BY : DESIGN REVIEW, FAULT TREE ANALYSIS (FTA), HAZARD ANALYSIS , FAILURE MODE EFFECTS ANA-LYSIS(FMEA) OR ERROR MODE EFFECT ANALYSIS (EMEA) AND PRODUCT LIABILITY PREVENTION

-- PROCESS DESIGN ENGINEERINGS ARE ALSO TO COM PLY WITH AS SAME AS DESING ENGINEERINGS PRO GRAM BASED ON MORE HUMAN-ORIENTED CONCEPT OF HUMAN-ERROR PREVENTION BY FOOL-PROOF METHOD

-- FOOL-PROOF IS ALSO MENTIONED AS POKA-YOKE FOR PREVENTION OF SLIP-MINDED OR ABSENT-MINDED HUMAN ERROR OR MISTAKE THAT ANY SAFE RELATED OR CRITICAL PROCESSES ARE ABSOLUTEL NECESSARY TO INSTALL FOR PREVENTION EQUIPMEM FOR IMPORTANT QUALITY CHARACTERISTICS ASSUR-ANCE

2-WEEK TRAINING COURSE
FOR FCAV, BRAZIL
UNIDO PROJECT
(TF/BRA/92/B10, DP/BRA/92/004)

POLICY MANAGEMENT

Yoshikazu TSUDA

RIKKYO UNIVERSITY

UNION OF JAPANESE SCIENTISTS AND ENGINEERS

UNION OF JAPANESE SCIENTISTS AND ENGINEERS
(NIPPON KAGAKU GIJUTSU RENMEI)
5-10-11, Sendagaya, Shibuya-ku, Tokyo 151, JAPAN

July, 1990

PROGRAM
FOR
QUALITY MANAGEMENT

Management for Strategy
Through
Management for Objective

Prof. Yoshikazu TSUDA
Rikkyo University

Management for Objective
v. s.
Management by Objective

I. WEAKNESS OF MANAGEMENT BY OBJECTIVE

When we listen to people's speaking carefully, We may hear so many complaints caused by management by objectives why people has so many complaints to management by objectives ? we would start first from this phenomena.

OBSERVED PHENOMENA

COMPLAINTS OF MANAGERS OF MIDDLE LEVEL:

1. Objectives are imposed by his superior, and he has not so much possibility to select objectives by himself.

2. In many case he can not help committing to the imposed objective although he has no idea to achieve it.

3. Being afraid to be fired if he could not achieve it, he can not propose challenging target in his objective.

4. He can not know the relation of his objectives to the objectives of his colleagues.

COMPLAINTS FROM EXECUTIVES:

5. There are so many objectives which have not been achieved.

6. What objectives are good and attractive ? There are no idea and no systematic approach about them.

7. Much reluctance by subordinates to commit objectives.

8. MBO is being in practice, but it isn't working well.

For the convenience of further discussion, definition of "Objective" should be made exactly.

OBJECTIVE = MEASUREMENT OF RESULT(PERFORMANCE)
+ TARGET VALUE IN THE MEASUREMENT

Then we can identify discussion points on MBO a little more in detail.

A. How to develop tree structures of objectives(chains of objectives) from top to bottom.

B. By what procedure, people can reach consensus on each one's objective.

C. How to assemble a set of objectives in accordance with one's responsibility.

D. What consideration is required to select objective (measurement).

E. What points people should pay attention to objective (target) setting.

The management for objectives will be the answer to above questions.

MANAGEMENT FOR STRATEGY THROUGH MANAGEMENT FOR OBJECTIVE

II. PROCEDURE OF MANAGEMENT FOR OBJECTIVE

Execution of management means to follow up the cycle of PDCA - Plan, Do, Check, Action. Each step in management for objective is described as follows:

PLAN:

From Top to Bottom;
(Set up the long range or middle range plan, if one company have not it yet, in the executive meeting. Set up annual execution schedule according to the long range plan)

1. Evaluate last year performance of company operation based on the long term managing plan. Examine closely the reasons of insufficient performance.
Examine countermeasure and preventive action for next year's plan.

2. Make up (provisional) implementation plan of this year according to annual schedule of long range plan considering last year's performance and examined actions.

3. Discuss with divisions' (departments') heads presenting this year implementation plan, and ask them to break down the plan according to their responsibility.

" *Break Down*" means to give more concrete image to the presented plan as objective (measurement and target) from their responsible field, and to deploy executable ways (methods) in their responsibilities to materialize target.

EXAMPLE 1 :
Plan presented by CEO : TO REALIZE HIGHEST QUALITY IN INTERNATIONAL MARKET.
Response from VPs by translating president's message into their responsibility

* Production VP : Realize 5 year free warranty with trying to prevent cost increase as less as possible
  - Production manager : 50% reduction of defective fraction. 5% direct cost reduction per unit.
  - Production Engineering : 30% reduction of loss time caused by machine trouble
  - Purchase Manager :
  - etc.

* Product Development VP : Develop 5 new products of 15% cost reduction
  - Movement Development Group Leader : Develop 30% cost reduction model for big torque movement and 10% cost reduction model for alarm clock
  - Case Development Group Leader : Develop 3 wall clock and 3 alarm clock by 50 % of failure cost reduction of product development stage

* Sales VP : 20% market share increase in fleet customer(customer of industrial company) market, 15% turnover increase in consumer market by improving customer service quality

- — etc.

EXAMPLE 2 :
Policy presented by Board of Directors:
CONTRIBUTE LOCAL COMMUNITY THROUGH PROSPERITY OF THE COMPANY.

RESPONSE FROM VPs :

* Production VP: Zero accident. No lay off by introducing new products and increasing flexibility of work in worker and supervisor.
(with detail plan of his subordinates as follows)
  - Production Manager : To give a training for 12 workers as NC machine programmer and robot trainer, etc.
  - Production Engineering Manager : Safety: fail safe care installation to 80% major machines.

* Sales VP: Stabilize order input to Production, less than + - 5% of previous order. (detail plan)
  - Sales Manager : Increase visits to major customers. Adopt two stages order receipt: advance order and confirmed order.

— etc.

In "Break Down" process, a division head has to discuss with his subordinate on the given policy or plan, and needs to ask his subordinate to report on the present status and to analyze the way to realize it.

It is the PENETRATION PROCESS OF MANAGING POLICY FROM TOP TO BOTTOM.

4. To hold a meeting by CEO and division head, discuss proposed break down plan from *synthetic* view point. To adjust and re-arrange those plans proposed by each division, and make up new implementation plans with the consensus of all attendants.

The adjustment and re-arrangement of the plans is the BOTTOM UP PROCESS OF EMPLOYEES' OPINION ON THE MANAGING POLICY AND PLAN TO TOP EXECUTIVE.

5. To break-down the re-arranged plan by lower management level again. And make up "new break-down plans" for the presentation to top management.

6. To report step 4 and 5 several times till converging all level employees' discussion. Then board of management can determine the STRATEGIC PLAN of this year for long term management plan by all employees' consensus and participation.

7. This strategic plans are deployed as managing and checking points in each management level.

Here, TREE STRUCTURE OF MANAGING POINTS OF THE COMPANY POLICY FOR THIS YEAR is made.

Example of a strategic Plan:

STRATEGIC PLAN OF 1986 - QUALITY

* President: Realize 5 years free warranty and develop 3 years' battery change free wall clock
  as small profit loss as possible by
  1. Improvement of production quality
  2. Reduction of production cost
  3. Increase of the total sales

** Production Director : Reduce 10% production cost and improve reliability of products:30 % reduction of returned products for repair within the 1st warrant year
  - Production manager: 50% reduction of in-process fraction defective, 15% direct cost reduction per unit and built in reliability into product in production by,
    1. eliminating electrostatic shock and other major defects,
    2. fool-proof installation into working system,
    3. quality improvement of incoming material,
    4. realizing stable operation, less interruption.

Purchase manager: 7% reduction of material cost by 50% reduction of incoming fraction defective and 40% material inventory reduction by purchase lead time reduction

1. negotiation for cost reduction with major suppliers by giving stabilized order, increasing quantity order and technical support for quality improvement.
2. visiting to suppliers, production process with technical staff for quality improvement. (to the worst 5 suppliers)
3. developing supplier for critical reliability parts requested from design department.

Engineering manager : 20% reduction in field failure rate and 30% reduction of process loss time caused by machine trouble through,

1. Increasing process capability of critical parts processing,
2. Fool proof installation into machine,
3. Effective and complete preventive maintenance,
4. Quick response to repair call,

- Mechanic group leader: ———
- Electric group leader: ———
- Automation group leader: ——

** Product Development Director : Develop 4 model of 3 years' battery change free wall clock for fleet customer market.
Develop 3 new products of 30% MTBF increased and 15% reduced cost.
Modify design of ongoing products to realize 20% reduction of field failure rate by,

1. examining new raw material
2. intensive practice of Value Engineering
3. fool-proof installation into design

** Sales Director : 20% market share increase using 4 year free warranty as competitive feature in consumer market.
20% turnover increase of fleet customer market by promoting 3 years' battery change free new products. By

1. intensive public relation activities on warranty years increase,
2. good commitment to make a new product development from the beginning of collecting market information.
3. Trying to substitute all clock in a customer company by maintenance free new products.

– etc.

DO:

1. Execute implementation plan. .
2. To hold a review meeting in each management level of all division, evaluate progressing level by score in managing points, analyze the reasons of unexpected result, and examine countermeasure for them.

   ——— LOCAL CYCLE OF P-D-C-A IN MANAGING OF COMPANY POLICY.

   Review meeting should be held more frequently in lower management level.

   For example; Monthly in Department
   Quarterly in Division
3. To hold "QUALITY PROCESS REVIEW BY PRESIDENT(CEO)" to all divisions once a year.

   General implementation plan of "Quality Review by President (CEO)" is shown in lecture.

CHECK:

To evaluate all over performance of strategic plans at the end of fiscal year.

ACTION:

1. To analyze the reasons of both insufficient results and over achieved results. Examine COUNTERMEASURE and PREVENTIVE ACTION for next year.
2. Continue the step of PLAN described above.

EXERCISE

I. Convert Strategic Plan (refer to an example in section II) into three structure of Managing and Checking Points.

II. The Bread Company has 5 years middle range plan as follows;
1. To achieve 35% market share in 1989.
2. To achieve the highest consumers' nomination.
3. To expand product type from bread to cake-like bread and achieve 25% profit share by cake-like bread products.

And this year, policy made by president is as follows;
1. To increase 10% total sales by new products development.
2. To achieve the highest score of bread shop.

Please make up strategic plans (of each department) and deploy the three structures of Managing & Checking points for strategic plans.

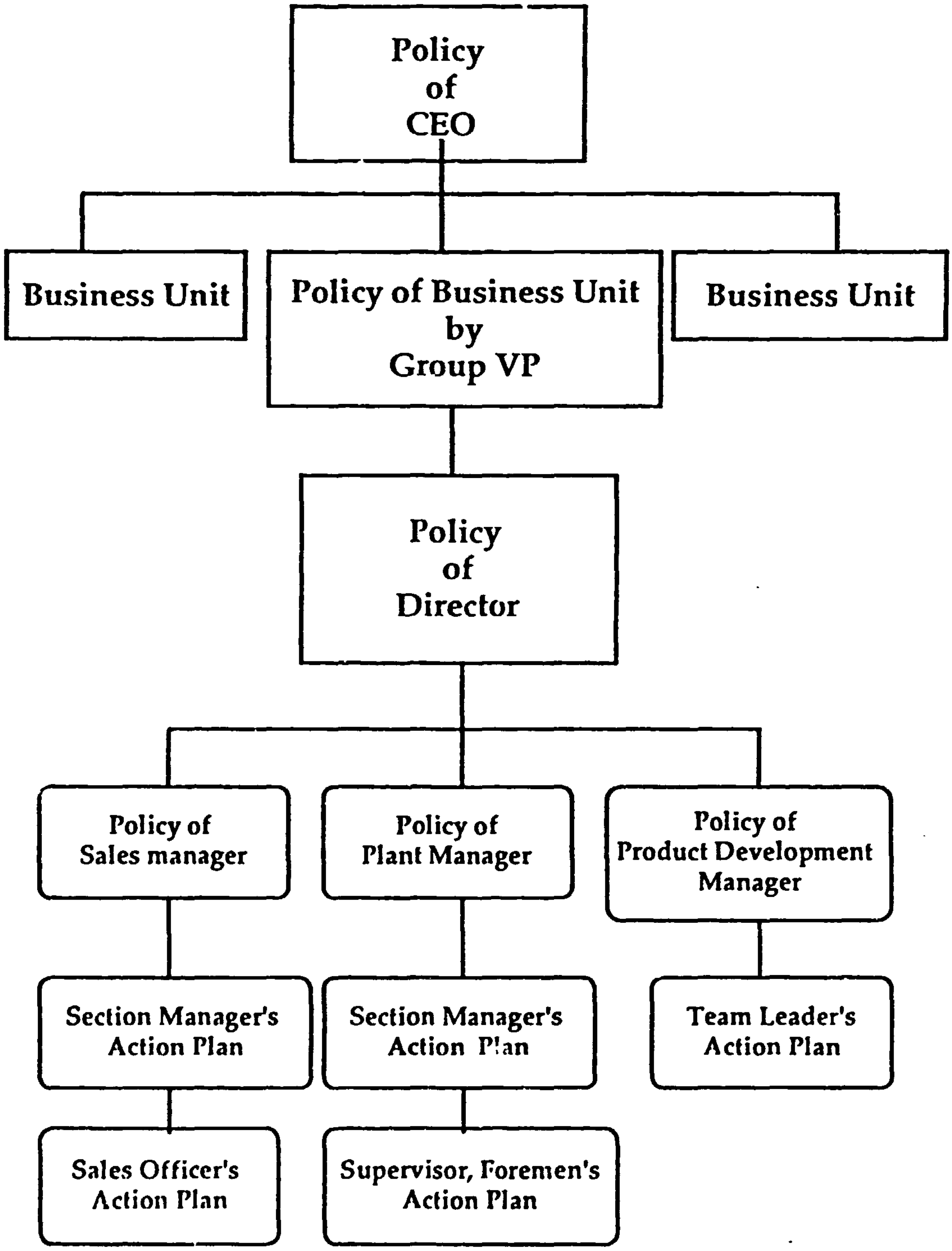
III. Answer to the questions presented in section I.

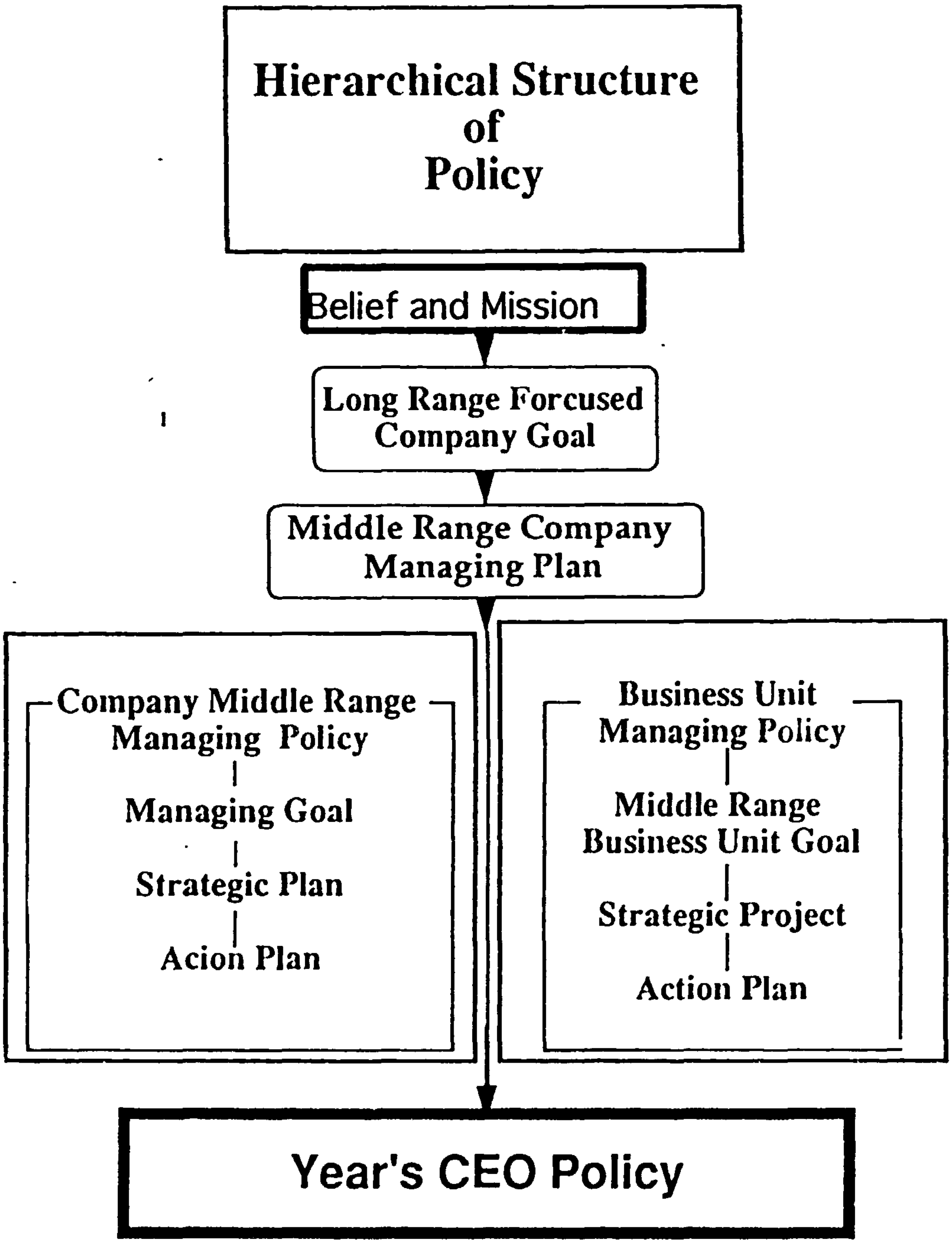
July, 1990

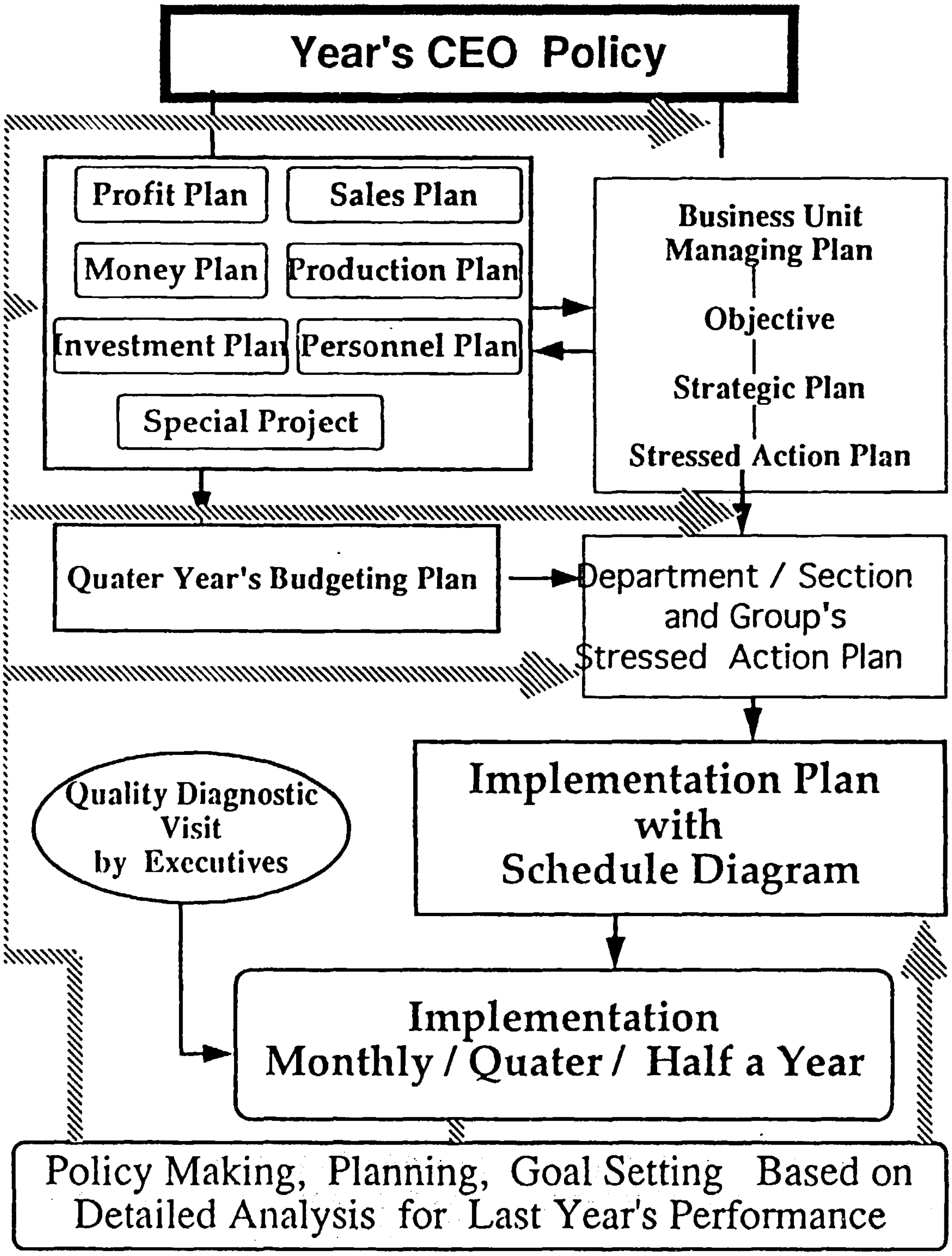
PROGRAM
FOR
QUALITY MANAGEMENT

Policy Deployment

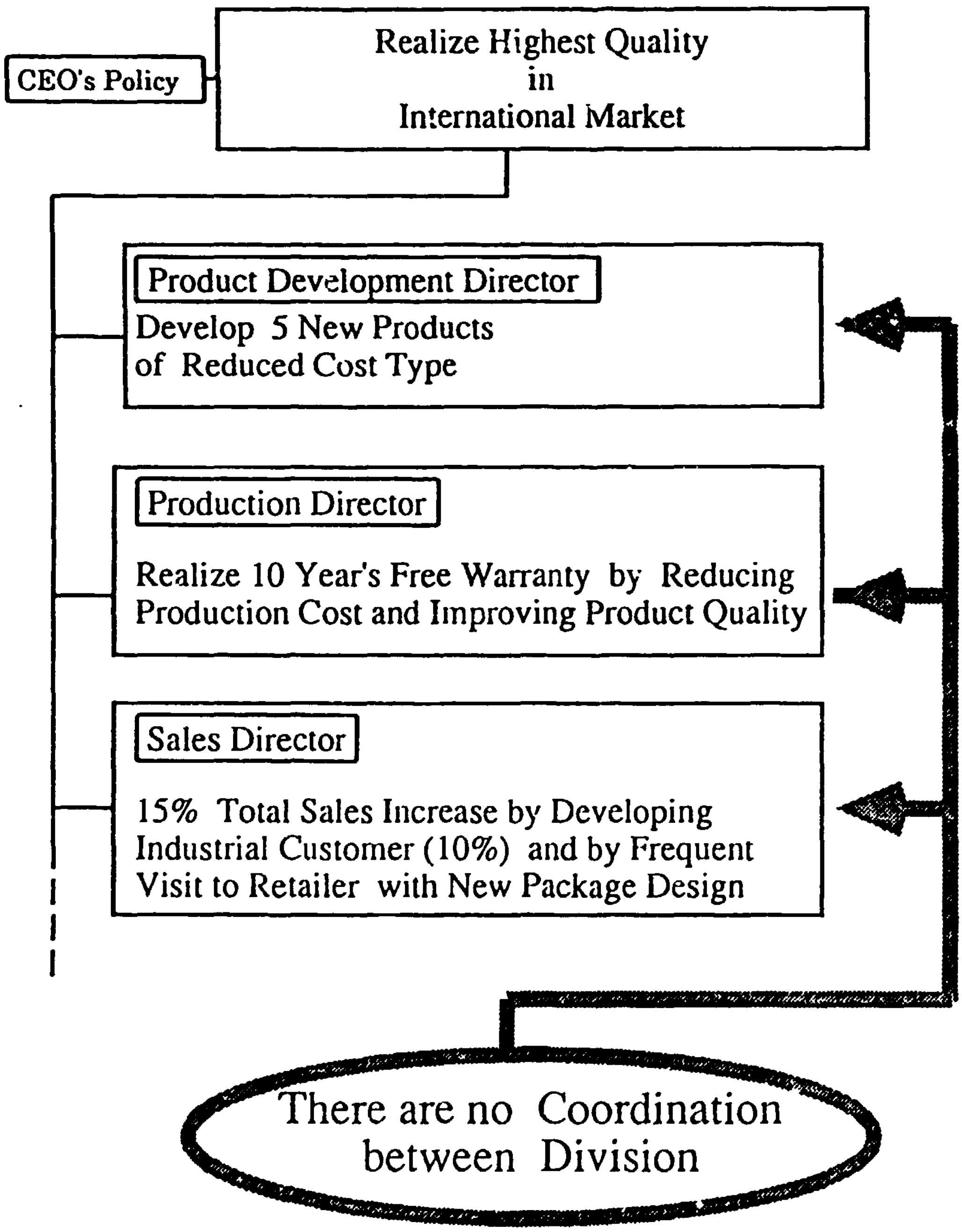
Yoshikazu TSUDA
Professor of Rikkyo University / Tokyo


Policy of CEO
Business Unit
Policy of Business Unit by Group VP
Business Unit
Policy of Director
Policy of Sales manager
Policy of Plant Manager
Policy of Product Development Manager
Section Manager's Action Plan
Section Manager's Action Plan
Team Leader's Action Plan
Sales Officer's Action Plan
Supervisor, Foremen's Action Plan


Hierarchical Structure
of
Policy
Belief and Mission
Long Range Forcused
Company Goal
Middle Range Company
Managing Plan
Company Middle Range
Managing Policy
Managing Goal
Strategic Plan
Acion Plan
Business Unit
Managing Policy
Middle Range
Business Unit Goal
Strategic Project
Action Plan
Year's CEO Policy


Year's CEO Policy
Profit Plan
Sales Plan
Money Plan
Production Plan
Investment Plan
Personnel Plan
Special Project
Business Unit Managing Plan
Objective
Strategic Plan
Stressed Action Plan
Quater Year's Budgeting Plan
Department / Section and Group's Stressed Action Plan
Quality Diagnostic Visit by Executives
Implementation Plan with Schedule Diagram
Implementation Monthly / Quater / Half a Year
Policy Making, Planning, Goal Setting Based on Detailed Analysis for Last Year's Performance

Example of Deploied Policy



After theTalk amoung Directors Coordinated Objective

CEO

Realize Highest Quality in International Market

5 Year's Free Warranty

Product Development

- Develop 5 New Product of High Reliability Alarm Clock
- Develop Low Power Cunsumption Clock Movement Unit to realize 3 year Battery change Free
- Develop New Package targeting to Young Consumer

Production

- 10% Production Cost reduction
  - by Improving Asset Utilization
  - by Reducing Quality Difect and Scrap
- Increase Product Reliability
  - by Improving Purchaseing Material Quality

Sales

- Total Turnover 20% Increase
  - Using 5 year Free Warranty as Competitive Force
  - by Announcing 3 year Battery change Free to Industrial Customer and/or New Package Design
- 15% Turne over Increase in Industrial Customer
- 10% Turne over Increase in Consumer Market

How people are able to be Creative

CEO's Policy

Contribute Local Economy through Company's Prosperity

Production VP

Zero Accident
No Lay-off by Introducing New Products and Increasing people's Flexibility

- **Production Manager**
  Train 12 worker as NC machine Programer etc.
- **Production Engineering Manager**
  Check all Production Line to
  Install Fail Safe Care for Safety etc.

Sales VP

Stabilize Order Input to Production per every Month, Fraction less than + - 5% of Previous Month's Order

- **Sales Manager**
  Increase Visit to Major Customers
  Adopt two stages order receipt:
  Advance Order and Confirmed Order

Policy Deployment Format

1988 Director's Policy

Date of Issue	Date of Revise	Approved by

Superior's Policy	No	Objective

Analysis of Objective Setting and Stressed Action Plan Fromulation

Graph Histogram etc.

No	Objective			Last Year's Actual	Stressed Action Plans			Person in Charge
	Category(What) of Objective	Goal	Action Limit			Goal of Action	Action Schedule	

2-WEEK TRAINING COURSE
FOR FCAV, BRAZIL
UNIDO PROJECT
(TF/BRA/92/B10, DP/BRA/92/004)

DAILY WORK MANAGEMENT

Yoshikazu TSUDA

RIKKYO UNIVERSITY

UNION OF JAPANESE SCIENTISTS AND ENGINEERS

UNION OF JAPANESE SCIENTISTS AND ENGINEERS
(NIPPON KAGAKU GIJUTSU RENMEI)
5-10-11, Sendagaya, Shibuya-ku, Tokyo 151, JAPAN

March, 1990

PROGRAM
FOR
QUALITY MANAGEMENT

Building up Quality Process in Indirect(servicing) Work

Yoshikazu TSUDA
Professor of Rikkyo University, Tokyo

CONTENTS :

1. Introduction

In 1979, I was in London with my family, and one day we went to the travel center at Paddington Station to buy railway and Sealink tickets. A railway ticket and seat reservation from London to Harwich, a Sealink ticket and cabin reservation between Harwich and Hoek van Holland, as well as a railway ticket and seat reservation from Hoek to Amsterdam were to be purchased as a total set of six ticket for each member of my family.

Unfortunately the place was very crowded and there was a long queue behind us. But the male British Rail officer did not seem to be rushed and wrote out carefully each and every one of the 18 ticket for the three of us, and put front and back covers to each set and stapled then together.

Since we had been feeling a bit uncomfortable by then, we felt relieved with the expectation that now he would hand the sets of tickets to us. But the railway officer picked one of th three ticket sets and opened it, and began to pull with his fingers each ticket one by one to see if they were all securely stapled together or not.

At this points, my wife began to laugh, and to the railway officer who gave us a dubious look, she said that what he was doing is a splendid example of quality, but since so many people are waiting, we would like the tickets now and we would check the effectiveness of the stapling ourselves. With this! we finally received our tickets.

Had this taken place in Japan, one would have paid attention to the long queue of waiting customers, and tried to speed up the work while giving less attention to detail.
And the customers would also take this for granted.

In such a case, which is the right way? The Japanese or the British?

2. Service and Quality

Let us assume that a rough definition of service is 'all work excluding direct production of things(manufacturing).'
This means that all indirect area of manufacturing - not only general affairs and accounting, but development, production engineering, etc., - would also be part of service.
The work of a production section manager would be a service too.
Then, we begin to feel that CWQC(Company Wide Quality Management), implemented in manufacturing industry, is not exclusive to manufacturing. When we think this way, we feel more comfortable.

In manufacturing industry, products are produced, and service industry produce services. But this distinction is a relative on, for product-related services are provided by manufacturing while products are supplied along with service by service industry, for example, in restaurants.

Then what difference are there in terms of quality? In quality control in manufacturing;

a. Quality for the User — Fitness for Use — is emphasized.

Also, an emphasis is placed on a perception of quality from many angle, such as

b. Functional Quality and Competitive Quality, as well as
Commonly Expected Quality and Attractive Quality.

As all qualities are expected of service industry as something natural, we can say that there is no difference between manufacturing and service industries with regard to quality. Then, what are the characteristics of quality in service industries?

My present answer to this question is that the characteristics of service industry with regard to quality do not exist in quality itself but in the methods of assuring quality. Then, how do they differ from the case of manufacturing industries.

A. Difference in time and space allowance between manufacturing and delivery.

In manufacturing, there is often time between manufacture of a product and it's delivery to the customer, and confirmation of product quality, by inspect ion or other means, can be performed by the manufacturer independently from the user.

In service industry, however, there is neither much time nor space between production of a product (service) and delivery to the customer. Usually the delivery takes place instantly, face-to-face with customer, as you can imagine the job of clerk in front of counter desk in a bank.

B. Difference in the form of product delivery.

Services, unlike products, are not delivered all together in one step after completion. Instead, their delivery seems to be going on simultaneously during the process of production. Face-to-face sales, bank windows and restaurants are examples illustrating this point. Thus, in service industry, there is no time to confirm the quality of the service before delivering it to the customer. Quality must be fully built into the service in the process.

C. Required quality depends on the situation.

The fact that customers' quality requirements for service vary extremely according to situation is clearly illustrated by my experience with the British Rail that I described in the beginning. If only a few persons were waiting behind me, I would have been quite satisfied and enjoyed by the job done by the railway officer. Perhaps another person might have been undisturbed and very much satisfied by his job even with many people waiting behind in a long queue.

In manufacturing industry, quality with a fixed target is materialized in the process, but in service industry, the selection of the Standard of Quality is mostly left to the people who work in the process. Therefore, in service industry, one must make a sufficient study regarding Basic Quality, or what is the quality which must he fully built in during the process stage.

I find the job of the British Rail officer very agreeable because it seems to me to be a manifestation of what might be a Western conviction that quality should always be constant and not be changed according to the situation or people one is dealing with.

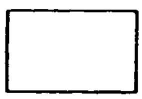
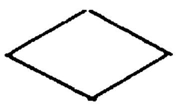
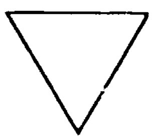
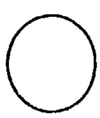
In closing this section, I must give my own answer to the question arisen at the beginning of this section. My answer is that neither the British nor the Japanese way is correct, but what I would like to see is a realization of 'British Quality at Japanese speed.' But is there a way to achieve this? Let us leave the answer to the discussion after section 3.

3. Process in service — Advantage of process analysis

Before industrial production underwent the division of work as t exists today, in the age of handicrafts, it was said that a person was a full-fledged craftsman if he could make a program of his work. We could say that this means he is fully qualified as a manager before he is ready to become a master who own his work.

In fact, a study of a work procedure is closely related to management. The main purpose of this paper is to build up a plan of management through analysis of process of work.

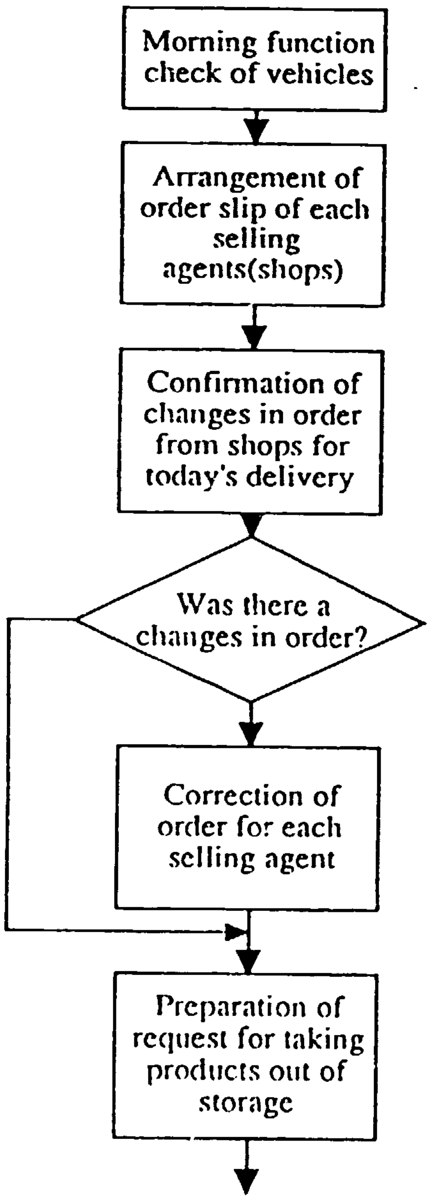
First the minimum number of symbol needed for drawing flow diagram of work procedure(process) will be explained. The symbol are borrowed from 'Flowchart Symbols for Information Processing' and 'Process Chart Symbols.'

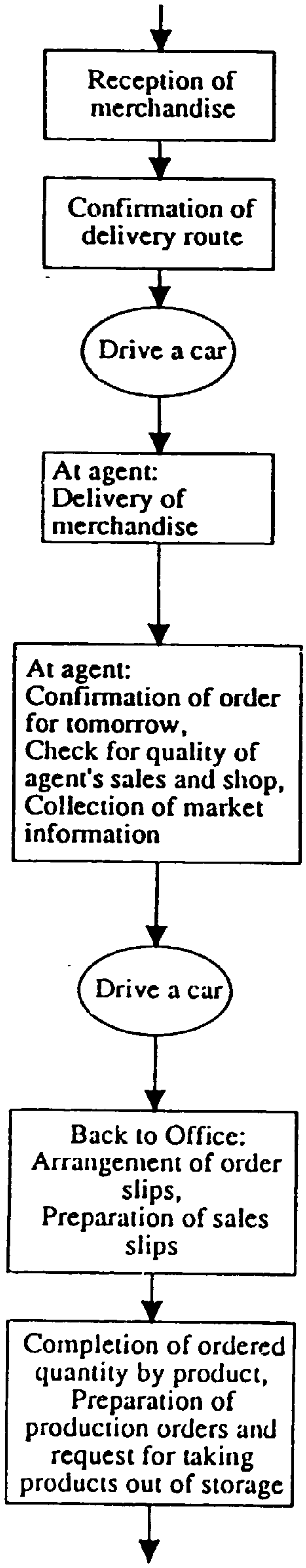
Symbols	Meaning
	Processing: Performing a job which constitute a unit
	Judgement or decision
	Tie-up or storage
	Transport

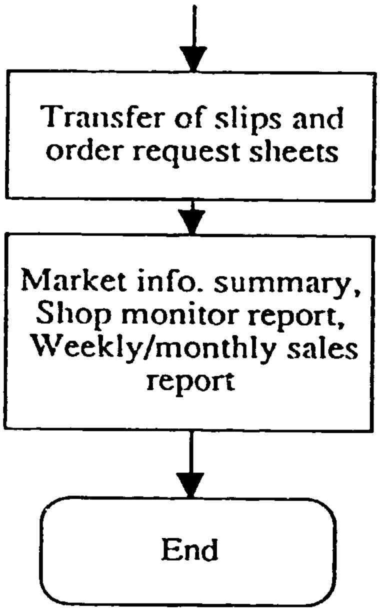
Now let us use these symbols to make diagrams of work flow.

Example: Daily work of a salesman of a Bread Company

Let us consider the daily work of a salesman working in a small or medium-scale bakery firm. And also let us assume that the program of the work for this salesman is to receive today's supply of bread from a production warehouse, deliver it to the sales agents (shops), get order for the next day, compile these sales and order figure after returning to the office, and send the sales slip, production orders, and requests for taking products out of storage respectively to the accounting, production and shipping sections.




Reception of merchandise
Confirmation of delivery route
Drive a car
At agent: Delivery of merchandise
At agent: Confirmation of order for tomorrow, Check for quality of agent's sales and shop, Collection of market information
Drive a car
Back to Office: Arrangement of order slips, Preparation of sales slips
Completion of ordered quantity by product, Preparation of production orders and request for taking products out of storage



As the above diagram is only a flowchart of salesman's daily work, let us add on one side of the chart the responsible person and department, checking points for processing in each unit of job, and the standards and documents needed for processing, that are provided by organization aiming to support people's work for easy and better quality.

Now the program of work is quite detailed. I named this type of diagram a "**Process Flow Diagram**"

Process Flow Diagram of Sales Person's Daily Work

Flow of Work	Responsible person	Checking Points	Standards / Documents
Morning function check of vehicles	Sales person	Safety of Vehicles, Cleanliness of cargo & compartment.	Vehicle Safety Checking Manual Periodical Disinfection Standard
Arrangement of order slip of each selling agents(shops)	Sales person	Variation from quantity of Standard Order Table.	Standard Order Quantity Book
Confirmation of changes in order from shops for today's delivery	Sales person	Reception of change order from agent by people other than in charge of that customer.	Standard Form of Telephone Reception Memo
Was there a changes in order? (Yes / No)	Sales person		
Correction of order for each selling agent	Sales person	Check and confirm for production order and product request order changed correctly?	Copy of Production Order(Form)
Preparation of request for taking products out of storage	Sales person	Quantity cross-check by agents and product type.	Standard Form of Product Request Slip

Process Flow Diagram of Sales Person's Daily Work

Flow of Work	Responsible person	Checking Points	Standards / Documents
Reception of merchandise	Sales person, Warehouse person.	Quantity, Product package outlooks, Production date.	Packaging Quality Standards Product Preservation Code
Confirmation of delivery route	Sales person	Traffic information by radio, Urgent delivery request.	Territory Route Map Urgent Delivery Request Form
Drive a car	Sales person	Product condition in cargo room, Safety in drive, Road condition to avoid Product damage.	Safety Drive Manual Refresh Training of Safety Drive Technique
At agent: Delivery of merchandise	Shop manager, Sales person.	Quantity / Product type, Package quality, Damaged products and those quantity.	Product Quality Standard On Site Product Delivery Manual
At agent: Confirmation of order for tomorrow, Check for quality of agent's sales and shop, Collection of market information	Sales person	Variation from standard order, Product handling manner in sales & house keeping of shop, Complaint for product, Soled quantity(actual), Event in surrounding area, New product info. in competitor.	Order Form Sales Agent Management STD Complaint Report Form Market Info. Report Form
Drive a car	Sales person	Condition of product in cargo room, Safety in driving.	

Process Flow Diagram of Sales Person's Daily Work

Flow of Work	Responsible person	Checking Points	Standards / Documents
Back to Office: Arrangement of order slips, Preparation of sales slips	sales person	Quantity difference between order and soled in actual	Production Forecast System
Completion of ordered quantity by product, Preparation of production orders and request for taking products out of storage	sales person	Order quantity change by agent, after receipt of order, Event and weather forecast - for sales quantity forecast for tomorrow.	Standard Form of Telephone Reception Memo, Sales Quantity Forecast formula
Transfer of slips and order request sheets	Production planing person sales person	Timing of transfer	
Market info. summary, Shop monitor report, Weekly/monthly sales report	sales person Sales manager	Consumer's complaint, Complaint of shop, Accuracy of daily forecast, Trend of population in territory, Trend of sales, Information of new building, Hints for new product	Quality Report Form Shop Claim Handling Manual Control Charts of Sales, Forecast Accuracy, etc., New Product Propose Form, Agent Application Code.
End			

4. Process flow diagram for division of work in department and sections

The process flow diagram that we have drawn is a picture of the flow of work at the employees' level. Next, let us draw a flow diagram a work of organization, that is, the flow of work a department or section.

Employment of personnel is used here as an example, as the division of work of Personnel Department. The size of company is slightly larger that the bakery company mentioned previously.

Comparing these two process flow diagrams, that of sales person's and that of personnel department, we can recognize clearly that there are different levels of eye point observing these two process of works. To describe process of organization's work, we need to adopt more global and longer time span view point than that for individual employee's work.

Process Flow Diagram of New Recruitment ... Personnel Department

Job Flow	Responsible Dept.	Checking Point	Standards, Documents
Demand of Man Power	All Departments		Standard Man-hour Table, Job Description
Excess Work Force	All Departments	Introduction of automation and electric data processing, Progress of rationalization in work, Long rang trend of average age.	
Reception	Personnel Dept.	Reception from <u>All</u> department	Personnel Request Form
Internal Transfer Meeting	Personnel Dept., Manager of Personnel	Matching of qualification between that of required and that of candidates	Employee Transfer Code
Agreement (no)	Person who is nominated, Manager of Department, Personnel Dept.	Candidate's will, Agreement between managers sending and accepting	
Shortage of Man Power after Relocation	Personnel Dept.	Company policy of personnel Long range business plan Priority for demands	Brief and Mission Long / Middle Range Business Plan
Recruitment Plan	Personnel Dept.	Justification by Brief and Mission and long range business plan, Priority, Business and technology trend.	Personnel status indices; trend of average age, ration of direct and indirect, Share of personnel cost in total expanse
Approval for Plan (no)	Executive Committee	Matching of business plan, Justification by Brief and Mission, Matching between needs and ppriority	Brief and Misson, Long range Business Plan

Process Flow Diagram of New Recruitment ... Personnel Department

Job Flow	Responsible Dept.	Checking Point	Standards, Documents
Determination of Qualification and Employment Condition	Personnel Dept. & Dept. requesting human resource.	Qualification requirement, Employment condition - salary, allowance, benefit etc.	Personnel Employment Code. Salary Table,
Public Announcement Plan	Personnel Dept.	Selection of announcing channels (news, magazine etc.) Selection of recruiting organization	List of public employment office List of private personnel agency List of School and University
Approval (no → Determination of Qualification and Employment Condition)	Personnel Manager	Appropriateness of announcement channels(New & Magazine) and recruiting organization Budget	Recent history of recruitment
Announcement	Personnel Dept.	Confirmation of announcement (same as plan) Number of inquiry per announcing channel and recruiting organization	Standard announcing format

5. Processing, checking points and managing points

In the section 3, the daily activity of one member of Sales Section was expressed in a process flow diagram. In section 4, employment of personnel, one of the important task of Personnel
Section , was described in a process flow diagram. When the checking points of the employment flow diagram in section 4 and those in the sales flow diagram of section 3 are compared, we find that the checking points in the employment flow diagram are for checking to see if each group of processing is done well or not whereas the checking points of the sales flow diagram are the descriptions of each processing operation .

How does this difference come about? Actually, the daily work of a member of Sales Section correspond to a 'processing' in the process flow diagram of one of the divided task of Sales Section. This means that the flow diagram in Section 3 is on a different level from that of the section 4. If the checking points for the daily work of a Sales Section member are considered in term of the corresponding checking points at the level of a task of Sales Section, there will be the following five:

- Change in quantity delivered,
- Quality complaint from selling agent,
- Change in the total quantity of sold in sales agent,
- Ration of excellent selling agents,

and

- Frequency of issue of market quality information.

As you can see, the purpose of checking points is to assure the result of each every 'Processing' of an organization such as departments or sections. On the other hand, the scale for measuring quality, that is the result of an entire task of an organization, is called managing points.

But this distinction between managing points and checking points is a view seen by manager of an organization. From the viewpoint of a member of an organization, managing points are things that measure the performance of his part of work. Therefore, here we see a simple structure in which the checking points of upper position's are the managing points of the lower rank.

6. How to find managing points

As I stated earlier, managing points and checking points are defined as follows :

Managing points: a scale for measuring result of work.

Checking points: points for checking used for assuring the results or work (before they were measured).... they are also scales if considered as data.

Checking points become clear by drawing a process flow diagram for each of the main task divisions. As stated in section 2, quality assurance in service industry is characterized by the impossibility to perform inspection. This tell you how important it is to define and respect checking points .

The way to identify managing points is to draw a process flow diagram, use it as a basis of discussion with as many people as possible, and to make efforts to find the measure of quality which is the result of the overall work. By this way, we shall be able to adopt managing points that are agreeable to all people in organization.

7. Implementation of management

The method for finding managing points was discussed in the preceding section. A good manager usually has good managing points, but the opposite is not always true, because even when a person has good managing points , he cannot become a good manager if he does not know how to implement management using those managing points and checking points .

The answer to the question 'what does mean management?' is simple.

Management is to turn the wheel of the PDCA cycle.

Let us discuss the P-D-C-A cycle at another occasion, and here we shall briefly touch on the functions of management. The function of management can be divided into the following three items :

Maintenance = Maintaining the level of quality of results of work (measured, for example, by managing points) that has been reached up to now.

Improvement = Planning for improving the existing quality standard of work results and implementing such plan.

Breakthrough = When existing methods and improvement ideas begin to slow limitation or become depleted, completely new ways of thinking, methods and techniques are developed in order to prepare for a future leap.

In these managerial functions, obviously the weight becomes greater in the order of maintenance, improvement and breakthrough as one goes from the lower to higher levels in the organization .

Exercise

1 . Process flow diagram, managing points and checking points become very concrete and easy to think when a manufacturing situation is taken as an example. A recipe for baking bread at home has been given to you. Using this information as a basis, prepare a process flow diagram for baking bread at industrial level, as well as a list of checking points and managing points in process. This example also provides an exercise for preparing the process for industrial and enterprise levels based on the experience at an experimental level . - Refer text book of 'Tree structure of managing and checking points in a whole company.'

2 . Formulate a concrete methods for achieving the British Rail quality of issuing tickets with Japanese speed, the problem discussed in the section 2.
Hint : An answer will be found if the problem is examined from the viewpoints of standardization.

8. Development of required quality and managing points

When managing poin's are prepared on the basis of a process flow diagram according to the method described previously, the tendency is to adopt only the measure of results of work, heavily reflecting the view of quality as seen by manufacturer and suppliers (of service). This is a deviation from the QUALITY FIRST ideal and CONSUMER—(PROCESS of DOWN STREAM) ORIENTED philosophy of CWQM (Company wide Quality Management).

In order to avoid such mistakes, it is necessary to utilize **deployment of quality requirement and quality - quality characteristics matrix.** Let us consider the example of the managing points of the Personnel Department described in the section 4. After a process flow diagram is drawn and studied for several major task of department's, let us suppose that the following points and their corresponding checking points are set up as the list of managing points for manager of Personnel Department.

Managing points	Checking points
1. Cost of employment per person	Number of applicants and acceptance ratio / used advertising channel
2. Absentee ratio	Sick absentee ratio Number of user of infirmary Overtime work duration
3. Rate of staying employed	Rate of absence without permission Wage difference index; compared with other firms of same business compared with neighboring companies Rate of participation in company events (celebration, recreation, etc.)
4. Number of suggestion of improvement	Number of suggestion per person
Number of adopted suggestion	Number of adopted suggestion per person by department Number of adopted suggestion of ranked excellent
5. Office work efficiency	Number of employee per one employee of Personnel department Number of error and rework in work / processing Overtime work duration in Personnel Computerization ratio of office work processing

The fifth managing point , office work processing, is not a measurement of result but is simply the name of an item. As no appropriate measure of office processing efficiency of Personnel Department was found, only the checking points in the process are listed.

Very often, it is very difficult to find appropriate measures of the quality of result of work. In such a case, checking points in the process are used as substitutes for managing points. But one should not forget the constant effort to seek and develop the scales to measure resulting quality.

Now, let us go back to the main theme and prepare a development chart of the quality required by Personnel Department. The main task of Personnel Section include obtaining a supply of manpower, participation of employee, preparation and implementation of training and education programs, salary and other calculation, as well as maintenance and management of employee records.

The attached sheet shows a required quality evolution table. This quality evolution table was written mostly from the standpoint of the recipient of the service provided by Personnel Department.

In order to see if the expected qualities are well covered by the managing and checking points on page 15, a quality - managing & checking points matrix has been prepared. It shows that certain qualities that are expected by external parties lack some managing and checking points. As we can see from the quality - managing & checking points matrix, the employment cost per person i s very important as an efficiency indices of Personnel Department. But seen from the outside, this should of course be good, and a complaint is voiced as soon as the cost deteriorates. Thus, on top of the basic quality or naturally expected quality, a more competitive quality, an improvement of at tract i ve quality as well as an index to measure the degree of perfection of these qualities are desired.

8. Evolution of Quality Requirement for Personnel Department

Managing points and checking points were made by manager of personnel department form his stand point. Quality requirement describe quality requirement for output of personnel department to other department from those people's view point.

In Quality Requirement - Managing & Checking point Matrix, some of managing points are not measuring quality satisfaction level in customer, that are 'Cost of employment,' 'Error & Rework of work,' and 'Overtime in personnel people.' That is natural. Because, personnel manager is responsible for all of quality of personnel department. The most of above mentioned measurement are concern to "internal quality" of personnel department, while quality requirement for personnel department describe "output(product) quality" of personnel department from customer stand point.

But manager of personnel department should become aware to the fact that some of quality requirements are not covered by his managing & checking points. This means, if he is working in manufacturing, his department is producing its products under the insufficient 'quality assurance.' He have to select several another managing or checking points to monitor the requirements that are not covered by his already existing managing & checking point.

Quality Requirement for Personnel Department

Primary	Secondary	Tertiary
Obtaining supply of Manpower	Supplies good quality manpower	Supplies people who are very cooperative
		People with excellent ability to understand
		People capable of flexibie thinking
	Supplies manpower when necessary	Supplies manpower quickly
		Supply of necessary number of people
	Supplies necessary manpower	supplies people who can perform immediately
		Supplies people with required qualification & experience
Support for personnel evaluation	Supplies good employee data	Provides well-maintained up-to-date data
		The educational background in the company can be clearly seen
	Prepares good method of evaluation	Provide fair method of evaluation
		Use the method of evaluation in a way conductive revitalization of the organization
Support education and training	Provide support for planning and implementation of a good educational program	Makes efficient arrangement whenever there is a need for education and training
		Makes follow-ups on education-training evaluation on a continuous basis
		Provide information on internal & external education programs on a regular basis
	Provides support for education and training which promote revitalization	Support for raising the level of Quality circle and suggestion of job improvement
		Provide good report on the status of revitalization
Promotion of participation of employee	Good monitoring of employees' health	Good publicity for health maintenance
		Good monitoring of health conditions
	Good reporting on state of working	Good reporting on state of working
	Monitoring and information on treatment of employee	Proper monitoring and supply of information on salary and wage standards
		Monitoring and supply of information on fringe benefit

Quality Requirement (Tertiary)	Managing & Checking Points: 1. Cost of employment	Number of applicant	Acceptance ratio per announcing channel	2. Absentee ratio	Sick absentee	Users of infirmary	Overtime work duration	3. Employee's turnover	Absentee without permission	Wage difference; same business / neighbor	Participation to company event	4. Number of Suggestion	Excellent suggestion	5. Office work efficiency	Total employee per personnel employee	Error & rework	Overtime in Personnel	Computerization	Coverage of requirement by managing & checking points
Supplies people who are very cooperative		△						○	○										
People with excellent ability to understand		△											◎						
People capable of flexible thinking		△										○	◎						
Supplies manpower quickly																			Measurement is not provided
Supply of necessary number of people		○		○				○											
Supplies people who can perform immediately		○	○					○											
Supplies people with required qualification & experience			○																Insufficient measurement
Provides well-maintained up-to-date data				○	○	○		○	○			△			○			○	
The educational background in the company can be clearly seen															△				
Provide fair method of evaluation				○					○			○			○			○	
Use the method of evaluation in a way conductive revitalization of the organization								○				○							
Makes efficient arrangement whenever there is a need for education and training																			Measurement is not provided
Makes follow-ups on education-training evaluation on a continuous basis													○						Insufficient measurement
Provide information on internal & external education programs on a regular basis																			Measurement is not provided
Support for raising the level of Quality circle and suggestion of job improvement											○	◎	◎						
Provide good report on the status of revitalization								○	○		◎	◎	◎						
Good publicity for health maintenance					○	◎													
Good reporting on state of working				○	◎	○													
Good monitoring of health conditions				◎			○	○	○		○	○							
Proper monitoring and supply of information on salary and wage standards							○	△		◎									
Monitoring and supply of information on fringe benefit								△		◎									

Exercise

Select quality measurement to measure each quality requirement that is not covered or insufficiently covered by managing & checking points of personnel Department.

What is measurement for quickness of manpower supply.

What is measurement for supply of well qualified and experienced people.

What is measurement for good service of arrangement for people to receive training and education.

What is measurement for good follow-up of training and education effect.

What is measurement for the service of announcing training and education chance.

Structure
of
Daily Work Management

By
Yoshikazu TSUDA
Professor of Rikkyo University

Structure of Daily Work Management

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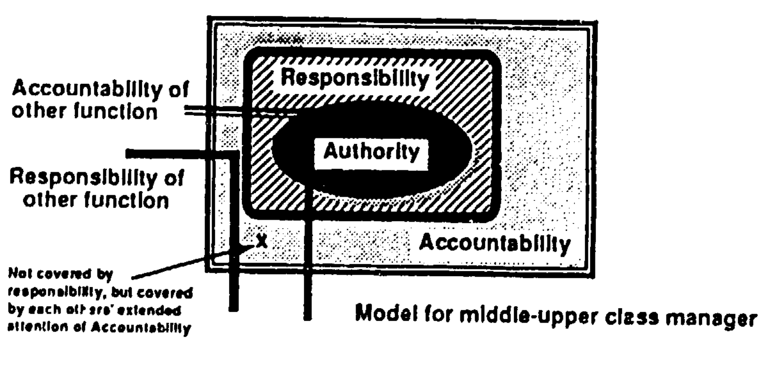
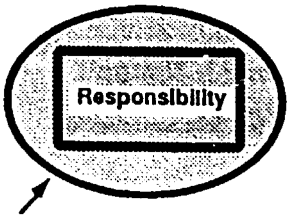
Authority / Responsibility / Accountability

Authority = delegated right of decision
Responsibility = responsibility for execution
Accountability = responsibility for business result



Authority / Responsibility / Accountability

Model for Top management



Authority and Accountability

- **Wide authority and accountability, instead of small responsibility due to delegation of authority for execution.**

Model for common people in company

- **almost coincided Authority, Responsibility and Accountability**

Daily Work Management
is
the Methods to take wide Accountability
under
limited Authority

How to Build up the Structure of daily work management?

> Choose **Managing Points** as the success indicator of your Accountability
>
> Choose **Checking Points** as the process indicator in your Responsibility

Managing Point and checking Point

What is managing point?

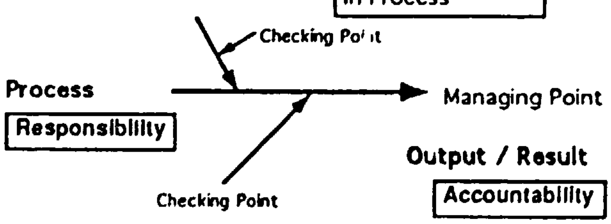
Managing Point = **Quality Measure of Output**

Managing Points are the Success Indicator
in
Quality, Cost, Delivery, Safety, and
Product Development

Managing Point and Checking Point

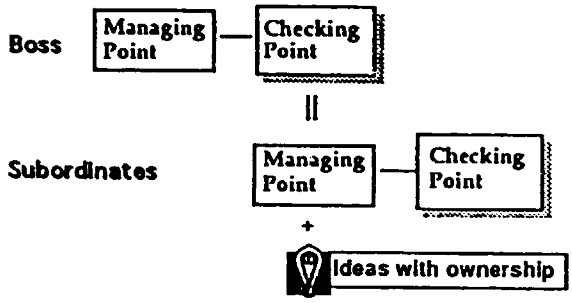
What is Checking Points

Checking Point = Measure, Information, Attention point, in Process



Managing Point and checking Point

Hierarchy of Managing Point



A Set of Managing Point for Manager

Managing point as monitoring measure
of his function's out put quality

.... stable measure year by year

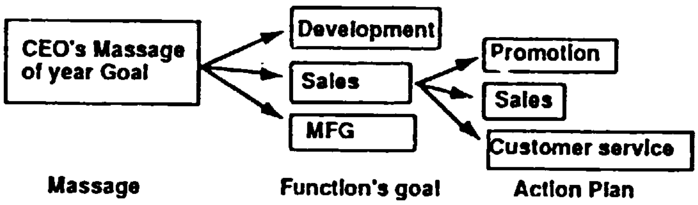
Managing point as a goal of year strategy

.... flexible measure according to the
change of year strategy

Consolidation
of
Deployed Chain of Managing Points

Top Down Phase

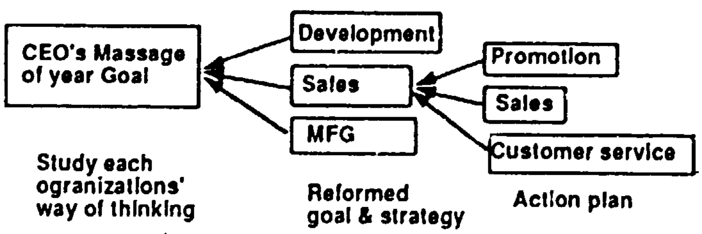
Division heads interprete CEO's Massage according to their their responsibility then set their function's goal. Department head succeeded goal of his boss, then create action plans to achieve goal.



Consolidation
of
Deployed Chain of Managing Points

Bottom Up Phase

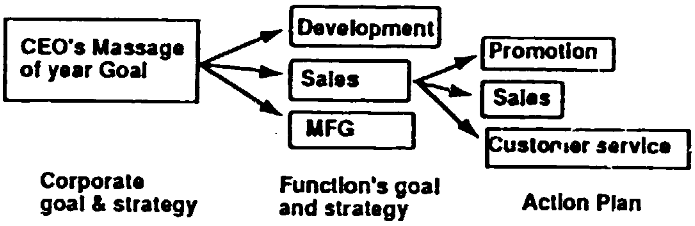
Division heads gather deployed action plans in his subordinate, then check feasibility of their goal, and reform goal and strategy. CEO gather goal and strategy of all divisions, then create corporate goal and strategy.



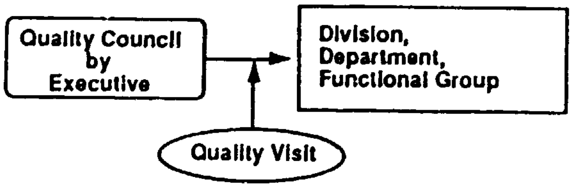
Consolidation
of
Deployed Chain of Managing Points

Again Top Down for Consolidation:

CEO issue corporate goal and strategy.
Division head interprete corporate goal to his function's goal with strategy.
Department head create action plan based on division's strategy



Doagnosis
of
Deployed Chain of Managing Points



Discuss: Appropriateness of choosed range and depth of accountability.
Appropriateness of selection of managing points & checking points.
Appropliateness of deployed action plans and those priority.
Implementation of action plan

System of In-Company Standards

Hierarchical Structure of Standards:

Corporate Standards — **Valid in the whole company:**
I.e. Corporate Vision, Brief & Mission, Business Guideline, Personnel Policy, Quality Assurance Guideline, etc.

Division Standards — **Valid in a Division:**
I.e. Product Development Procedure, Engineering standard, Maintenance standard, Cost counting rule, Product quality standard, etc.

Department Standards — **Valid in a Department:**
I.e. Claim handling rule, Purchase order form, Work order form, Operation standard, etc.

Section Standards — **Valid in a Section:**
I.e. Housekeeping tools storage board, Scrap handling rule, Telephone memo from, etc.

Type of Standards

Concept: *Description of way of thinking*
Corporate Vision, Brief & Mission
Business guideline, etc.

Procedure: *Description of requirement*
Cost accounting guideline,
Product development diagram,
Operation manual, etc.

Documents: *References*
Engineering standards,
Supplier list, Machine check list,
Parts list, etc.

Form: *Style, Document Form*
Policy deployment form,
Production order form,
Daily sales report form, etc.

Quality Visit
a
Milestone in Total Quality

It is a school of business in company.
In this school,
there are no separated role of teachers and students.
All people study from others and teach others
through
talking about their practices of TQM

By Yoshikazu Tsuda
Professor of Rikkyo University, Tokyo

Quality Visit
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Milestone in Total Quality

It is a school of business in company.
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there are no separated role of teachers and students.
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through
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Purpose

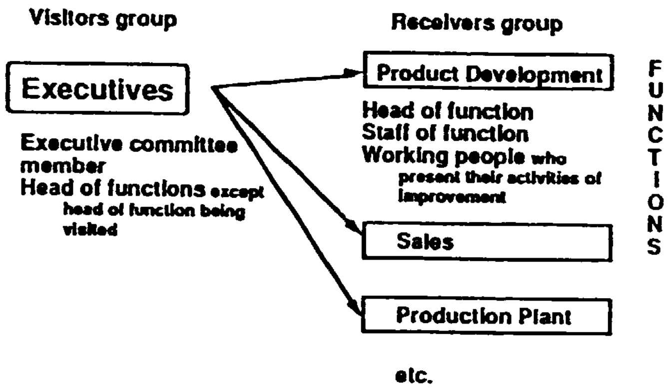
Aiming to encourage people
who are trying to be better in their work

Aiming to know what are the people's difficulty to be creative and challenging.

Aiming to know how quality is given the first priority in their work

Aiming to know more the process of quality than the result in quality like as usual performance review.

Who visit and Who receive visit



Agenda of Visit

Presentation by function head about quality result and their actions

Presentation about improvement by operating people and action team members

Question and answer seeing documents, records, manuals, method of working etc. visiting to working site

Short feedback about good, to be improved and suggestion of way of improvement

Effect of Visit

For Visitors:
* Improvement of communication between top and working people.
* Learning chance for top seeing reality of operation
* Training for top to be as top

For people who receive visit
* Refresh their way of thinking for managing process by writing report and presenting achievement
* Get input and suggestion for further improvement from different view point.
* Able to evaluate their progress comparing that of other functions

2–WEEK TRAINING COURSE
FOR FCAV, BRAZIL
UNIDO PROJECT
(TF/BRA/92/B10, DP/BRA/92/004)

QUALITY ASSURANCE

Tadashi YOSHIZAWA

TSUKUBA UNIVERSITY

UNION OF JAPANESE SCIENTISTS AND ENGINEERS

UNION OF JAPANESE SCIENTISTS AND ENGINEERS
(NIPPON KAGAKU GIJUTSU RENMEI)
5–10–11, Sendagaya, Shibuya–ku, Tokyo 151, JAPAN

Quality Assurance

- To assure quality in a product so that consumers can buy it with confidence and can use it long with confidence and satisfaction.

Dr. Kaoru Ishikawa

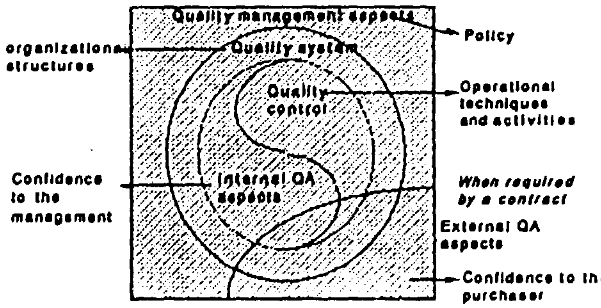
Quality Assurance, ISO8402

- All those planned and systematic actions necessary to provide adequate confidence that a product and service will satisfy given requirements for quality.

ISO9000 : Quality management and quality assurance standards

- ISO9001, *Quality system - Model for quality assurance in design/development, production, installation and servicing.*
- ISO9002, *Quality system - Model for quality assurance in production and installation.*
- ISO9003, *Quality system - Model for quality assurance in final inspection and test.*
- ISO9004, *Quality management and quality system elements - Guidelines.*

Relationship of concepts



Quality system elements 1

- Management responsibility
- Auditing the quality system (internal)
- Quality system principles
- Economics - Quality-related cost considerations

Quality system elements 2

- Quality in marketing
- Quality in specification and design
- Quality in procurement
- Quality in production

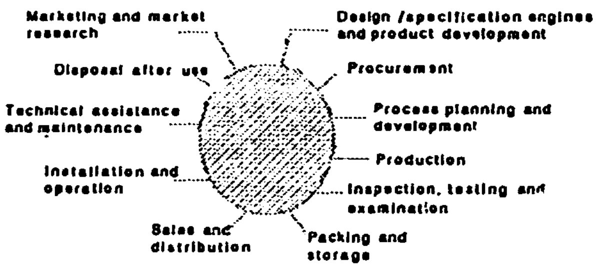
Quality system elements 3

- Control of production
- Material control and traceability
- Control of verification status
- Product verification
- Control of measuring and test equipment
- Control of nonconforming product
- Corrective action
- Handling and post-production functions
- After-sales servicing

Quality system elements 4

- Quality documentation and records
- Quality records
- Personnel (Training)
- Product safety and liability
- Use of statistical methods
- Purchaser supplied product

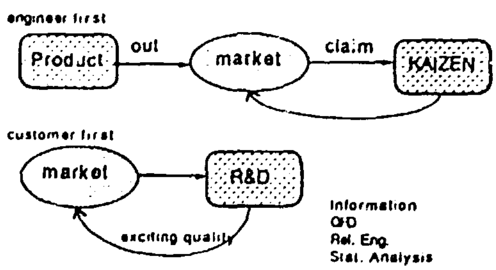
Quality loop



Changes of 5W1H in QA

	who	what	how	when	where	which
old	purchaser	eng. could	eng.	limited term	limited places	product
new	customer	customers require	eng./ mgt	life cycle	global	system service

Changes of 5W1H in QA



Customer

- external and internal
  - internal customer ≠ top management
  - =the following processes
  - external customer
    - consumer, user, purchaser, vendee, donor
    - regulation, environment
    - stakeholder(stockholder, employee, society)

Customer satisfaction

- Value
  - useful
  - high cost performance
- Confidence
  - safe
  - reliable, available
  - good after service
- Attractive

Customer relation and information system

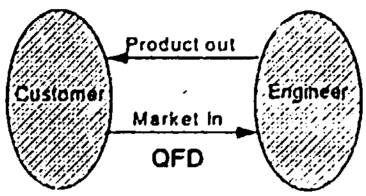
- claims
- expectations
- needs
- questions

QA-Technologies

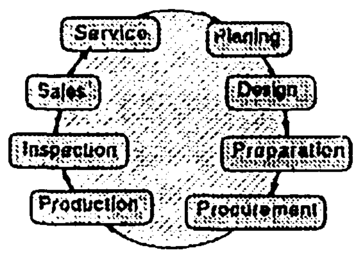
- QFD
- Reliability Engineering
  - Safety Design
- Statistical methods
  - Design of experiment, Taguchi method
  - Mulitivariate analysis
- Kaizen
  - QC-story
  - 7 QC tools

QFD

- Quality Function Deployment
- New product development



Steps of Quality Assurance



From customer's ground

- Selecting
- Ordering, Paying
- Receiving, Installing
- Keeping a warranty card
- Testing
- Using
- Maintaining
- Wasting, Trading-in

Quality Assurance Activities

- (1) QA for New Product Introduction
- (2) QA for Full Production Stage

- Market Research
- Product Planning
- Design
- Product Preparation
- Purchasing
- Production
- Inspection
- Transportation
- Sales
- Service

- Process Control and Maintenance Status Quo
- Improvement Activities to Raise Quality

QA for New Product Introduction

- Product Planning
  - Collecting and analyzing market information
  - Research and development
  - New product planning
    - QA items and quality level
    - Test specification
    - Extracting bottle-engineering
    - Cost reduction
    - Safety and Environmental Problems

QA for New Product Introduction

Design

- Conceptual Design, System Design, Detail Design
- Assurance Methodology
  - Quality Function Deployment, QFD
  - Design Review
  - Prototyping
  - Reliability Engineering
    - Failure-Mode and Effect Analysis
    - Fault Tree Analysis
    - Acceleration test
  - Quality Resident Engineer System

QA for New Product Introduction

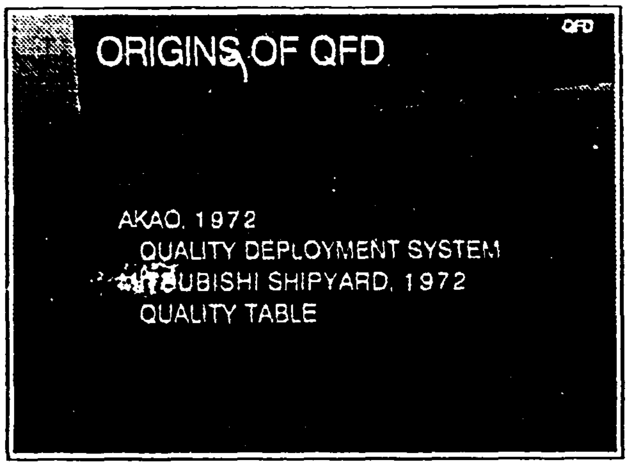
Production Preparation

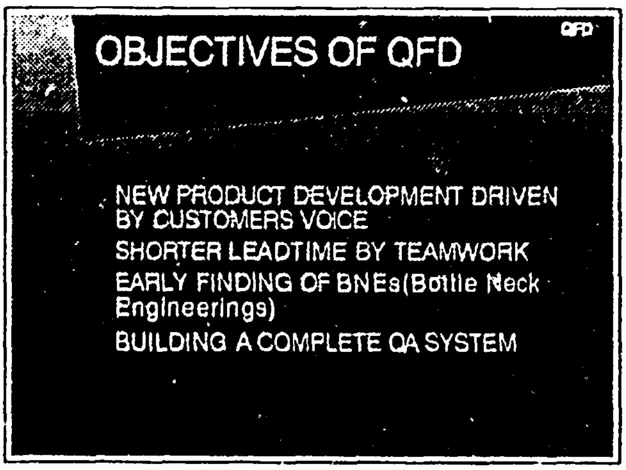
- Process capability Verification
- Process planning
- Foolproof devices, Poka-Yoke
- Process control standard
- QC process chart
  - Work standards sheet
  - Table of manufacturing conditions
  - Quality check standard sheet
- Inspection program and standard
- Pilot production

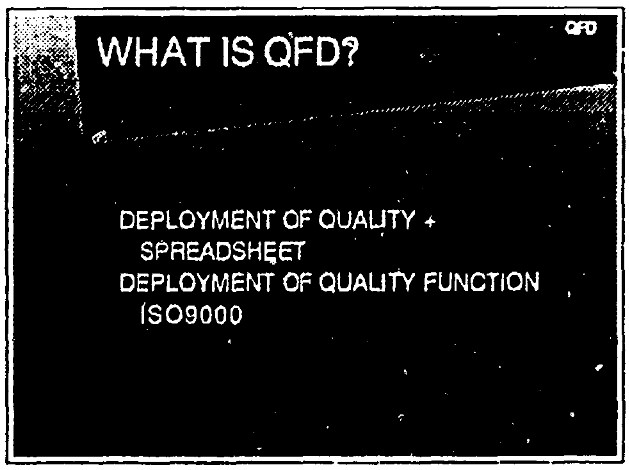
QA for Full Production Stage

- Process Control and Maintenance Status Quo
  - Conducting work according to work standards.
  - Understanding worksite conditions.
  - Immediate action to correct any problems and prevent recurrence
- Improvement Activities to Raise Quality


QFD
Quality Function Deployment
QUALITY FUNCTION DEPLOYMENT
品質機能展開
T. Yoshizawa, Professor
Graduate School of Systems Management
University of Tsukuba, Tokyo


QFD
ORIGINS OF QFD
AKAO, 1972
QUALITY DEPLOYMENT SYSTEM
UBISHI SHIPYARD, 1972
QUALITY TABLE


QFD
OBJECTIVES OF QFD
NEW PRODUCT DEVELOPMENT DRIVEN BY CUSTOMERS VOICE
SHORTER LEADTIME BY TEAMWORK
EARLY FINDING OF BNEs(Bottle Neck Engineerings)
BUILDING A COMPLETE QA SYSTEM


QFD
WHAT IS QFD?
DEPLOYMENT OF QUALITY +
SPREADSHEET
DEPLOYMENT OF QUALITY FUNCTION
ISO9000

DEPLOYMENT OF QUALITY

QFD

- QUALITY PLANNING
  - REQUIRED QUALITY LIST
- QUALITY DESIGN
  - QUALITY CHARACTERISTICS LIST
  - QUALITY TABLE
- SUBSYSTEM/PARTS DEPLOYMENT
- QC PROCESS DEPLOYMENT
- COST DEPLOYMENT
- TECHNOLOGY DEPLOYMENT

PRINCIPLES OF QFD

QFD

- CUSTOMER DRIVEN
- CONSISTENCY
- FLEXIBILITY FOR PURPOSES
- CONCURRENCY
- TEAMWORK

POINTS FOR USE

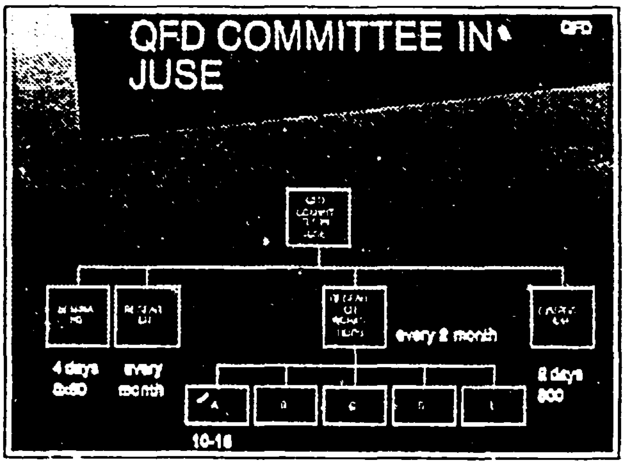
QFD

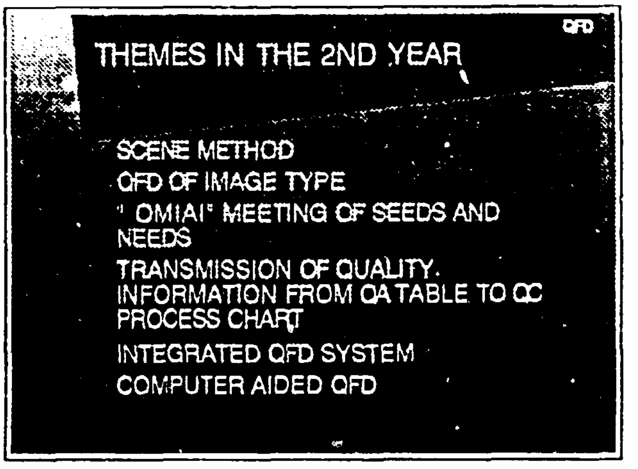
- BE CONSISTENT WITH TOP POLICY
- CLARIFY THE AIMS
  - WITH PRIORITY OR ALL TOGETHER
- DETECT THE CHANGE

RECENT STUDIES ON QFD

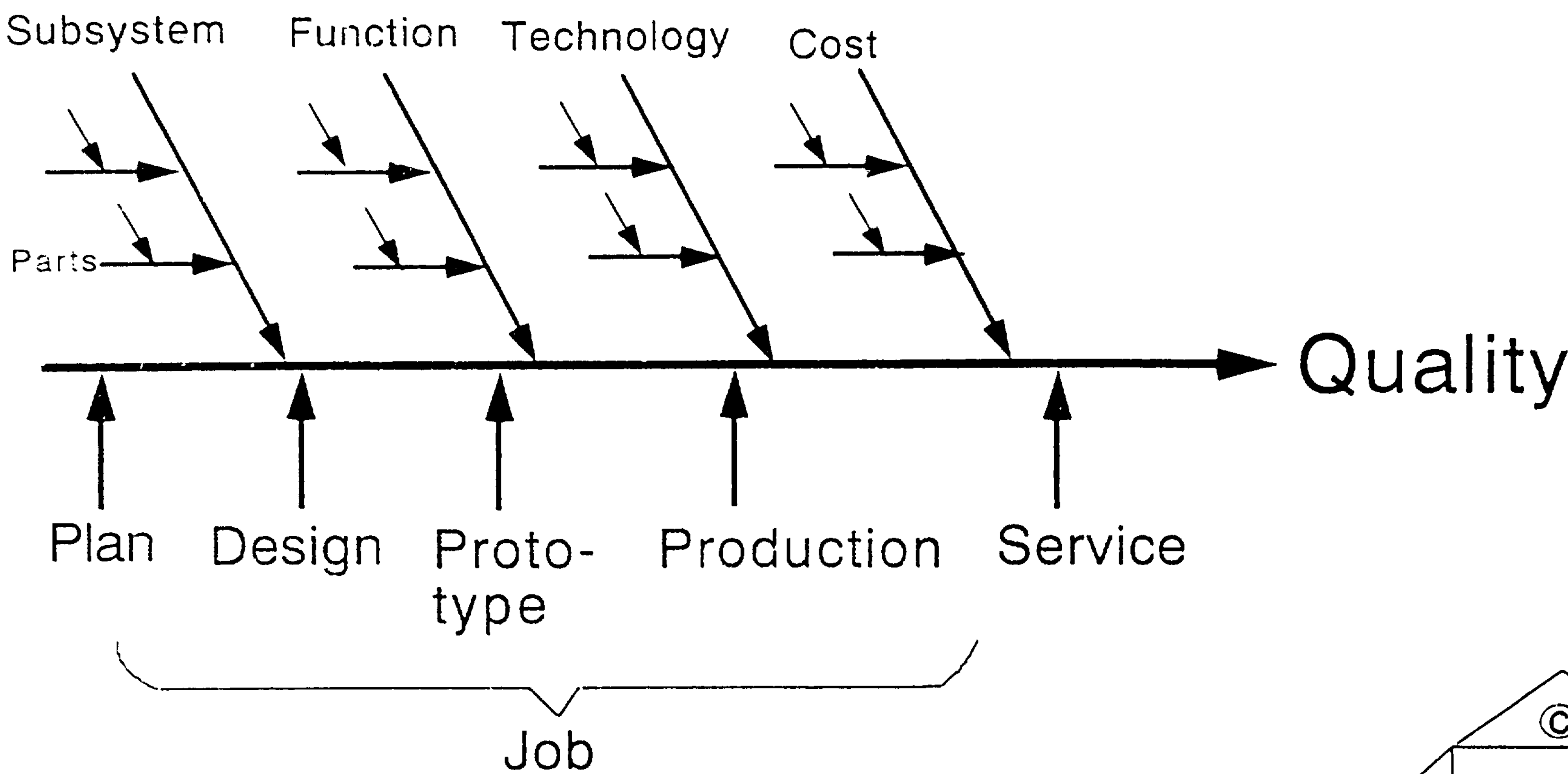
QFD

- SCENE METHOD
- QFD OF IMAGE TYPE
- " OMIAI" MEETING OF SEEDS AND NEEDS
- QUALITY STRATEGY DEPLOYMENT


QFD COMMITTEE IN JUSE
QFD
every 2 month
4 days
8x80
every month
8 days
800
10-16

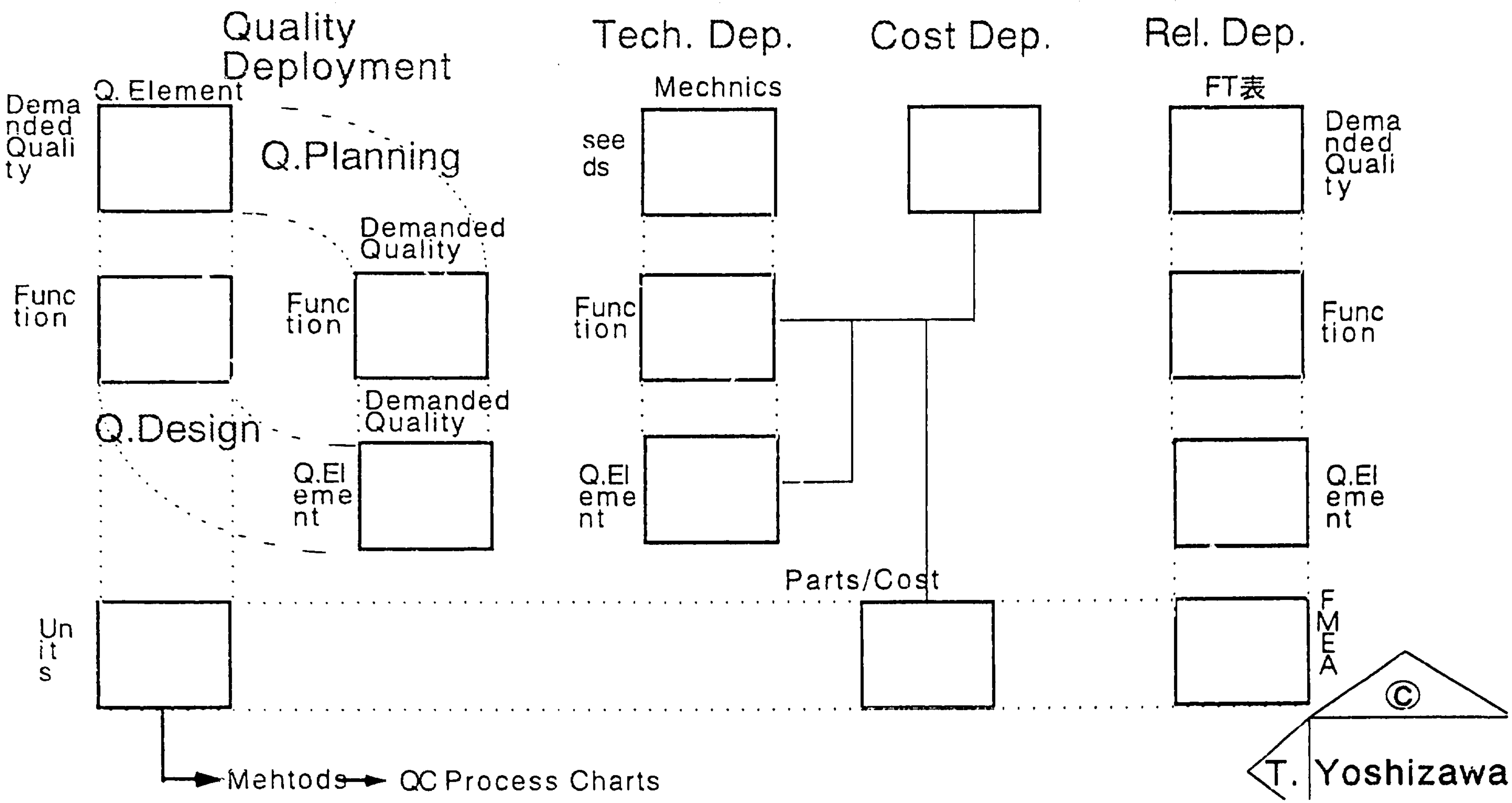

THEMES IN THE 2ND YEAR
QFD
SCENE METHOD
QFD OF IMAGE TYPE
" OMIAI" MEETING OF SEEDS AND NEEDS
TRANSMISSION OF QUALITY.
INFORMATION FROM QA TABLE TO QC PROCESS CHART
INTEGRATED QFD SYSTEM
COMPUTER AIDED QFD

Quality Network



QFD

Frame of QFD



COMPANY STRATEGIES AND QUALITY

QUALITY STRATEGY DEPLOYMENT BY MEANS OF QFD

TADASHI YOSHIZAWA, Professor,
Graduate School of Systems Management, University of Tsukuba, Tokyo
3-29-1 Otsuka,Bunkyo, Tokyo 112, Japan
Tel +81 3 3942 6871, Fax +81 3 3942 6829

ABSTRACT
Quality Strategy Deployment(QSD), which is a method for planning and analysis of quality management strategies in TQM, are described. The frame of QSD is a type of spreadsheet similar to that used in Quality Function Deployment (QFD). Total quality of management could be evaluated by QSD.

1. INTRODUCTION

Company-wide quality control (CWQC) has been evoluted, in the aspects of strategic management, in the direction of linking management of policies (MBP) with the corporate vision and the long-term management plan. M. Kogure (1984) proposed SMTQC (TQC for strategic management), which was one of the leading opinions in this area.

Joseph Juran (1989) has defined Strategic Quality Management (SQM) as a systematic approach for setting and meeting quality goals, and as the apex of the broader system of managing quality, throughout the company. G.K. Kanji et al.(1992) have shown how the characteristics of quality strategy can be linked to profitability through the management and market strategies of the total quality management process.

In recent years, management environment, both at home and abroad, has substantially changed. In addition of the global recession, the stakeholders' requirements have changed concerning the management and the corporate activities. Then every company have to listen harder than before not only to the voice of customers but also to that of the various stakeholders. The numerous requirements could be listed as the following examples: product liability demanded by consumers; protection of global environment from people; better work environment and shorter hours of labour by employees; more allotment by stockholders.

Therefore the former concept of quality and that of quality strategy which have placed the forcus on the product or the service should be extended in the direction of total quality. Now we need suitable indices for measuring the employee satisfaction (ES) and/or the stakeholders' satisfaction beside that of the customer satisfaction (CS).

Uchiyama (1992) studied our idea of quality strategy deployment (QSD) for setting and deploying the quality strategies based on the stakeholders' requirements using the spreadsheet similar to that used in QFD. In this paper, a standard frame of QSD, the principles of QSD, and the several points for the effective use of QSD will be dicussed along with concluding remarks.

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A2

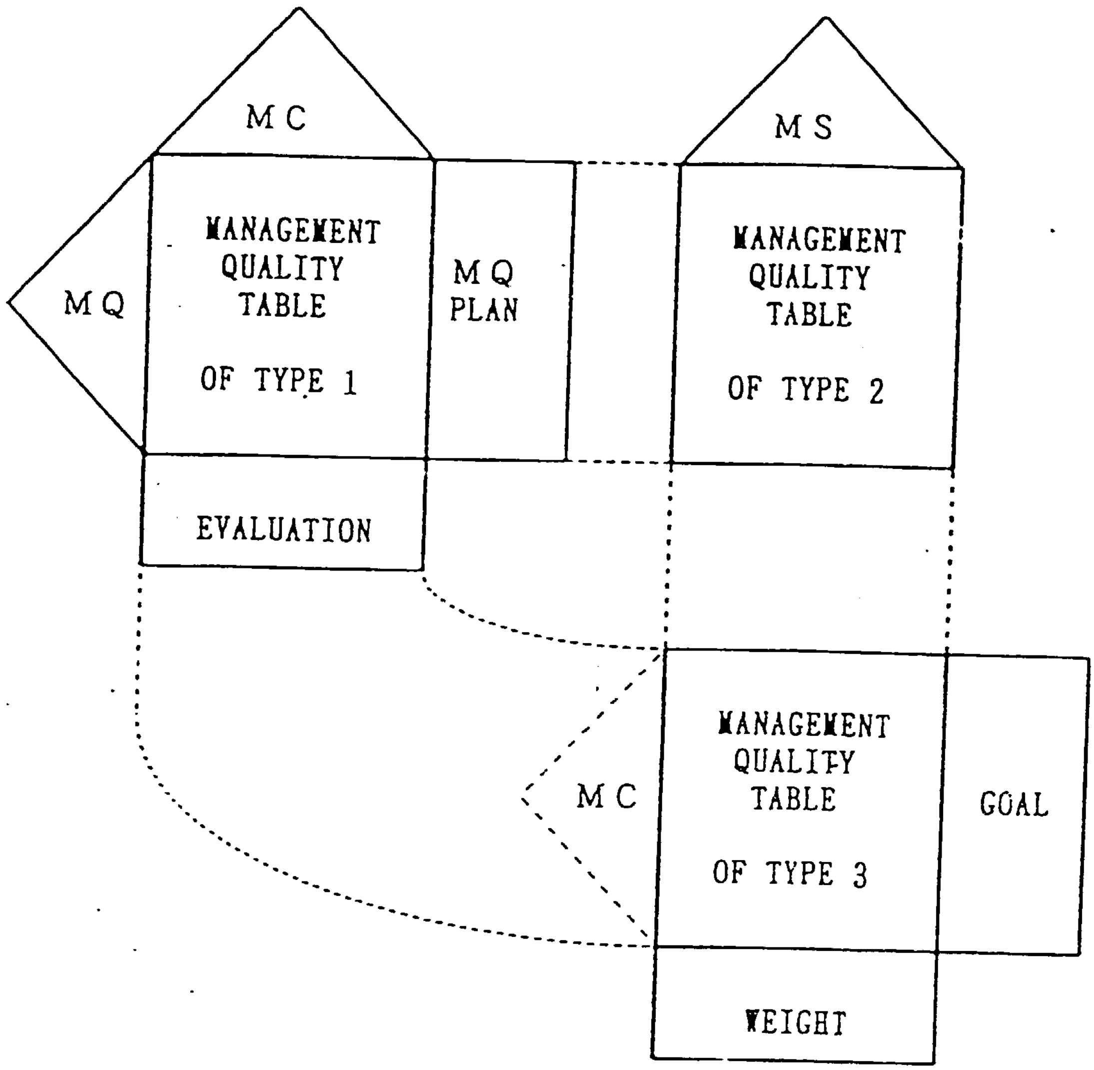

Fig. 1 Frame of QSD(Quality Strategy Deployment)
MQ: Management Quality Requirement List
MC: Management Characteristic List
MS: Management Strategy List

2. FRAME OF QSD

A standard frame of QSD is shown in fig. 1, where the three lists with tree structure, the three tables to the three pairs of the lists, and the several marginal tables, compose the spreadsheet.

We call the three basic lists of QSD "management quality requirement list (MQ)", "management characteristics list (MC)", and "management strategy list(MS)". The elements of those lists are the items demanded or expected by the stakeholders to the company, the management characteristics and the strategic elements, respectively.

The three tables of correspondence among the elements to three pairs of the lists MQ*MC, MQ*MS, and MC*MS, are called "management quality table" of type 1 , type 2 and type 3, respectively after the name of quality table in QFD. Each cell in the management quality tables is marked by double square, single square, triangle or empty by the intensity of correspondence. The major aim of those quality tables is to avoid self-satisfaction in making the lists of MC and MQ.

The margins of each tables are used for weighting and scoring the items in the lists, for detecting the change by the passage of time, and for setting goals of various objectives. Some of the purposes of working in the marginal spaces are to select the most important items, to recognize the changes in the requirements and reputation, to analyze the present level of management, and to set the objectives and goals in strategic management.

3. PRINCIPLES OF QSD

It is needless to say that the principles of TQM and/or QFD should be reflected in QSD. It seems to us that those reflected in QSD are the following principles:

(1) the thought of "customer-driven";
(2) the broad concept of quality that includes cost and delivery;
(3) company-wide deployment of cross-functions and technology;
(4) interdepartmental teamwork.

These principles are somewhat extended in QSD as mentioned below.

1) Stakeholders-driven

The thought of "customer-driven" in QFD means that the true quality exists in the customer space not in the engineer space, and that the quality demanded by the customers should be translated to the language of engineers and be transmitted to all departments. "Stakeholders-driven" is a major principle of QSD, although the importance of customer-driven should not be reduced. Moreover the severe trade-offs among the requirements from the different class of the stakeholders should be adjusted.

2) Quality of management

In TQM, the concept of quality has been extended to "total quality" that includes cost and delivery, and that includes even the quality of job and that of organization. In QSD, quality of management is designed and evaluated. It is also important there to clear the distinction between the demanded quality and the proposed quality.

3) Strategy as a cross-function

The integrated system of QFD has the subsytems of deployment for the cross-functions like quality-function (Q) , cost-function (C) or delivery-function (D) , and another subsystem of technology deployment to find out the bottleneck engineerings in new product development. Here, we use the term "cross- function" in order to stress the point that the concern of QCD should be considered to be related with every department. (Note that the english word cross-function was used by Dan Dimancescu (1991) for the first time.)

4) Quick response by interdepartmental team

It is usual in applying QFD that the interdepartmental team is formed. The interdepartmental teamwork makes QFD be effective to get better communication among the departments responsible for development processes and to get shorter leadtime for new product development. This fact may be the reason why the proposers of concurrent engineering have taken notice of QFD. Quality strategy should be treated in the management by cross-functions (MBCF). (Note that the translated term of MBCF is usually "cross functional management").

A

A2

4. POINTS FOR USE OF QSD

In this section, several points for use of QSD will be briefly described. The key words are detection of change , evaluation of competitive advantage, gap analysis, and linkage with MBCF.

1) Detection of change

It is the first step of QFD to grasp the stakeholders' requirements concerning the corporate activities and/or the quality of the management for a management quality requirement list (MQ). Using the MQ-list, we could weight the items of MQ-list, score the present response to each requirement, and compare the strength and weakness to the competitors. It is important to detect the changes in the management environment as the changes in the requirements by the stakeholders.

2) Evaluation of competitive advantage

At the second step, we try to establish the metric indices for evaluation of management, which is arranged as the management characteristics lists(MC). The MC-list will include CS , ES , and the various stakeholders' satisfaction as the primary items. The relationships among the elements of MQ-list and those of MC-list is analyzed by the management quality table of type 1. At this step, it is important for the company to evaluate the competitive advantage. The method of benchmarking could be useful for this purpose.

3) Analysis of gap and bottleneck

The third step is to sort the strategic elements as the management strategy list (MS) and to tabulate the management quality table of type 2 and that of type 3, which express the relation of MQ*MS and that of MC*MS, respectively. The gist of this step is to analyze the gap between the goals and the competencies and to find out the bottlenecks to realize the goals.

4) Linkage of QSD with MBCF and MBP

Management by cross-functions (MBCF) and management by policies (MBP) have been developed as the main tools in CWQC for strategic management. The basic policies concerning the cross-functions like QCD are planned and checked by the authorized committee of cross-functions in MBCF. Then for realization of the policies each department have charge of doing the plans. QSD would be more effective if it was utilized as the apex of the TQM system with MBCF and MBP.

4 2 14

5. CONCLUDING REMARKS

Quality Strategy Deployment (QSD) will be effective for the following purposes: to recognize the changes in requirements on the corporate management and activities from the various class of stakeholders; to evaluate and/or diagnose the corporate management internally or externally; to link the quality strategies with management by policies (MBP) and management by cross-functions (MBCF). QSD is expected to be applied to various nonprofit organizations as well as to business companies.

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RECENT ASPECTS OF QFD IN THE JAPANESE SOFTWARE INDUSTRY

TADASHI YOSHIZAWA
University of Tsukuba
Tokyo, 112 Japan

YOJI AKAO and MICHITERU ONO
Tamagawa University
Tokyo, 194 Japan

HISAKAZU SHINDO
Yamanashi University
Kofu, 400 Japan

Key Words

Quality function deployment; Software; Developing method.

Introduction

The Japanese software industry has cried for much higher productivity because it has had a huge backlog for several years. Various technical methods and tools of software engineering have been proposed to raise productivity in each process of design, coding, or testing in software development. However, they have had no success in getting higher productivity using an integrated method. One of the reasons for this failure may be that they have not recognized the importance of quality management in developing new products such as software.

Many Japanese companies in the manufacturing industry have succeeded in producing higher quality products rather than higher productivity using total quality control (TQC) as their management tool, especially those adopting quality function deployment (QFD). QFD is an integrated and customer-oriented system for developing new products of high quality, which was proposed by one of the authors of this article (Yoji Akao). The significance of QFD is widely recognized, even in the United States at the present time, to be effective for quality assurance in new product development.

In this article, some aspects of our recent study and movement in the Japanese software industry are reported. For the past 10 years, the number of articles and books related to QFD in software development has increased in Japan. An original plan for process management extending the method of deployment of quality function in QFD was published by the project team of IPA (Information-processing Promotion Agency). Finally, a case study of deployment of quality in software products will be described.

Brief Review of Recent Reports of QFD for Software

Figure 1 shows the number of papers related to QFD in all fields and those specifically in the software field by a solid line and a dotted line, respectively. Those papers were surveyed in four typical QC journals from 1967 to 1988 and during the proceedings of the symposiums on software quality control held by JUSE from 1981 to 1988. The four journals are Japanese "Hinshitsu," which is called "Quality" in English, of JSQC, "Hinshitukanri (QC)" and "Engineers" of JUSE, and "Hyojunka-to-hinshitukanri" (Standardization and QC) of JSA. It is characteristic that many cases of the utilization of QFD have been opened along with the academic research papers.

The promotion of TQC to the software industry has been led by the Committee of Software Production Control (SPC) of JUSE (chaired by Professor A. Kanno of the Science University of Tokyo) for the past 10 years. The SPC committee has held the above-mentioned symposiums, many courses on QC in software for managers and staff, and the research workshops by special members from the main framers and the software houses. QFD has been one of the most important subjects in those promotions.

The research of application of QFD to software development originated at the end of 1970s by the research group of Yamanashi University. At the time, the computer research committee (chaired by T. Yoshizawa) of JSQC and the research workshop of SPC studied QFD to adopt it in software development. For the sake of their research, it came to be widely recognized that QFD is a good model of new product development even in software products.

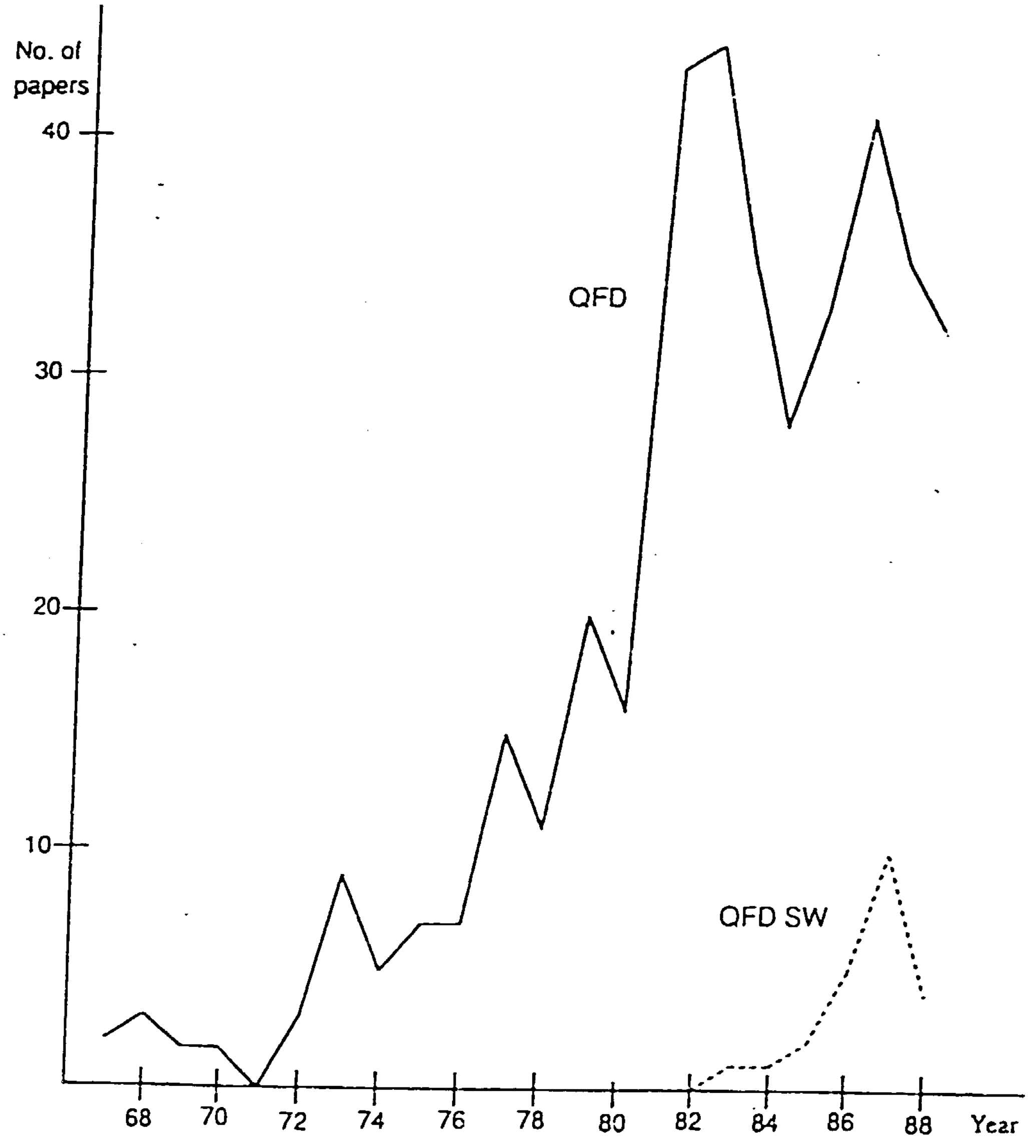

Figure 1. Change in the number of papers published.

The project team, which was organized in the technical center of IPA in 1985, proposed a guideline for application of QFD in 1986 and let three companies apply QFD along that guideline. The result of the project was published in a book titled *High Quality Software Development by QFD* (IPA, 1989), in which the guideline, the reports of three real cases, and various documents of quality tables and "QC-koteihyo" (QC-process tables, tables of planning the management in each process of development) were included. The main steps in the guideline are the following:

1. to tabulate customers' quality requirements as the true quality (TQ);

2. to make a quality table which expresses the correspondence between TQ and SQ (substitute characteristics of designers' technical requirements);
3. to make a table of correspondence between SQ and developing processes (22 processes defined in the guideline);
4. to make "QC-koteihyo" (QC-process tables) which specify the control items and the factor items to be checked in each process.

The QC-process table is a good tool up to now for the process control in the manufacturing line. It is a remarkable improvement that the IPA project extended the idea of the QC-process table to the management of complex processes in developing software products by carrying the customers' requirements through the quality chains in QFD.

Deployment of Software Quality

It is well-known that QFD originally includes the deployment of the quality and the deployment of the quality function. Simply speaking, the former is to carry the true quality of the target product grasped from the customer's voice to the subunits or the parts of the product through the technical characteristics. In the latter deployment of the quality function, the quality function means the responsibilities or the jobs of each section for developing new products. Then, the deployment of the quality function is, in a narrow sense, to carry the true quality to all jobs in developing new products. Now, QFD is an integrated and unified system for developing new products with an emphasis on quality assurance. In this section, the way of thinking for the deployment of quality itself in software products is described.

It is necessary at the first step of developing a software system to classify and arrange the required items of the users by grasping and analyzing the objects and needs of the users. The requirements/specifications obtained as an output of the above work should be exact, complete, and consistent. In defining the requirements, there are many problems to be clarified. For example, what kind of functions should be realized, and what level of performance for those functions the system should have. Then, a better technology for planning and defining the new software is needed.

An example of a schematic concept of the software development by deployment based on the quality in QFD is shown in Figure 2, where the numbers in parentheses represent the table numbers. The tables are the matrices which express the correspondences between two sets of items. For example, Table (1) in Figure 2 is the correspondence matrix between the demanded quality items (TQ) and the basic functions, and Table (4) is the correspondence matrix between the objects (input/output objects) and the quality elements (SQ).

It is very difficult for the users to show the exact details of their requirements and expectations by themselves, along with the rough sketch of the sys-

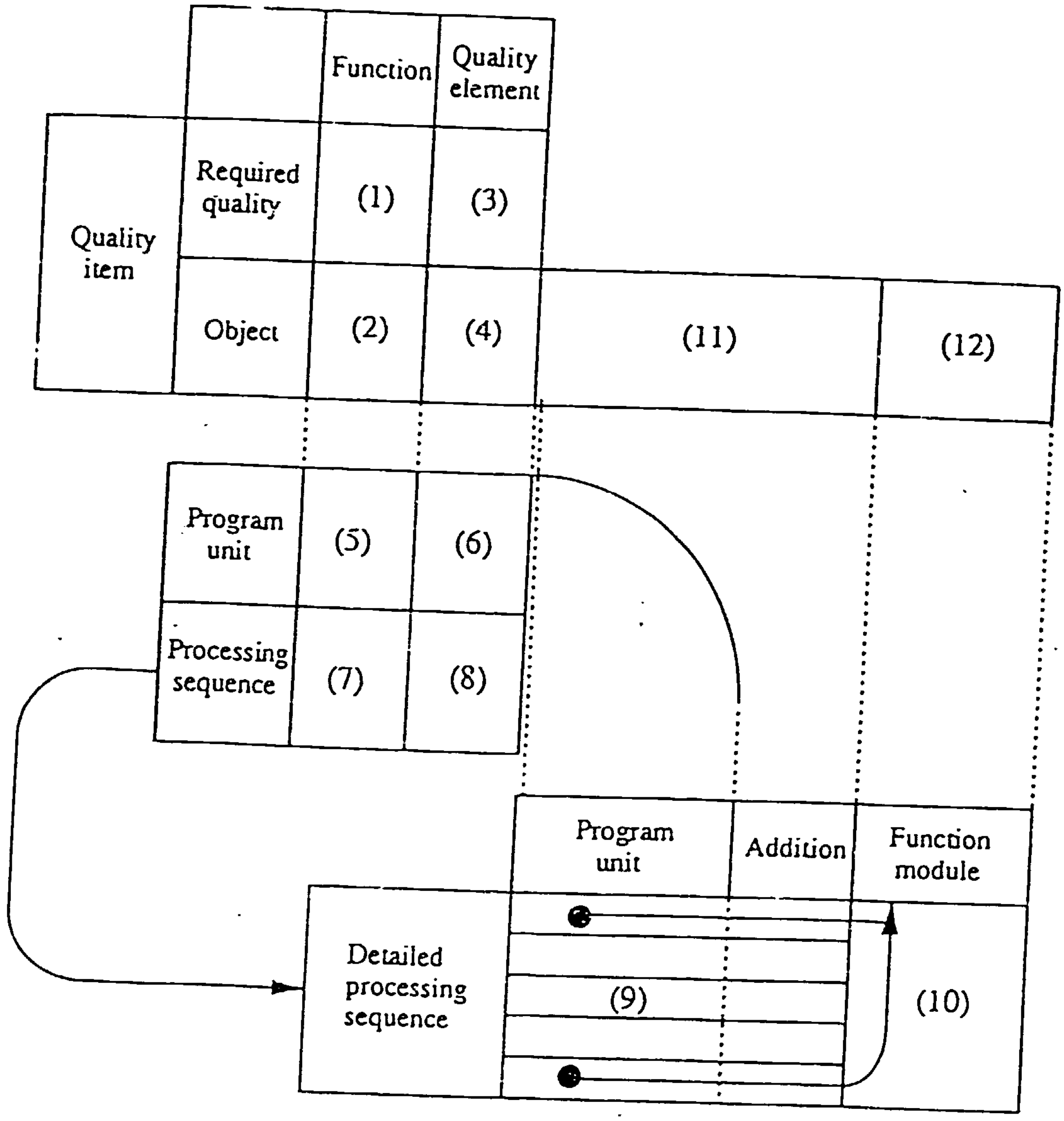

Figure 2. Schematic concept of software development employing quality deployment.

tem. Moreover, the user's requirements are often inconsistent and incomplete. Therefore, it is important to analyze the original information about the requirements from the various sources in addition to the analysis of the system. The required items are arranged in a tree structure with the primary, secondary, and tertiary items, and with the fourth and below if necessary, in QFD. The marginal items in Figure 2 are arranged in the tree structures.

Table (1) embedded in Figure 2 depicts the requirements of the functions. Table (2) makes clear which objects (input/output) are related to which functions. When building a software system, the input/output must be distinguished as the system objects (files). They can then be positioned appropriately in the quality deployment table.

When engaging only in system design, the quality tables (1) and (2) are the minimum requirements. To run the system more effectively and at a higher level, however, it is necessary to change the required quality to quality elements (or quality characteristics) and add on their matrixes, as shown in Tables (3) and (4). Functions must also be abstracted from the processing sequence.

A Case Study of Software Quality Deployment

An explanation will be given below, which focuses on an example of a quality deployment support system at the personal computer level.

In the quality deployment of software, the conventional required quality deployment table is made, as shown in Table 1.

Analysis of the Required Quality Deployment Table

Required quality deployment tables, made as in Table 1, are traditionally employed, but, as can be seen, the objects of the system, such as "required quality" and "quality elements," appear repeatedly. Because of this, these repetitions are taken out, and common adjectives and verbs are realigned in the same row to be evaluated. As a result, the following four questions about the expressions concerning the required quality are brought up:

Table 1. The Conventional Required Quality Deployment Table

Primary	Secondary	Tertiary
Input can be done easily	Input can be done quickly	Required quality can be input quickly
		Quality elements can be input quickly
		Language items can be input quickly
		Japanese characters can be input quickly
		The strength of relationships can be input quickly
		Information can be read quickly
		The size of the output table can be chosen quickly
		The code can be chosen quickly
	The input can be done accurately	The required quality can be input accurately
		Quality elements can be input accurately
		Language information can be input accurately
		Input information can be verified
	Input can be done easily	The required quality can be input easily

(a) Nouns such as "language information" and "required quality" appear repeatedly. Are these requirements or the objects of the system?
(b) Modifiers such as "accurately" and "quickly" appear repeatedly. Should these not be considered the same as quality?
(c) Verbs such as "can be input" and "can be displayed" appear repeatedly. Are these another way of replacing what can be considered a function, with the expression of quality, "can"?
(d) Terms such as "by using the keyboard" and "by using the mouse" are methods and measures. Should the underlying potential requirements not be pursued?

In reply, the above will be classified into the following three categories:

1. Required Items (Modifiers)
   These items will be further divided into the following two categories:
   (a) Quality: modifiers such as "accurately" and "quickly."
   (b) Measures or conditions: Required items which are expressions of countermeasures or conditions, rather than quality.
2. Objects of the System (Nouns)
   As the system is a quality deployment support system, the required quality and quality characteristics should naturally be input and output. In making software, the contents of the input/output should be made specific.
3. Functions (Verbs)
   In the execution part of the processing sequence, the object normally follows the verb and is made concrete, as in "do (verb) to (object)." These are often in the form "to be able to do so, and so," in order to define requirements. These expressions, however, should be considered the same as the simple "to do," and the verb should be considered a function.

Measures and conditions in required items are more appropriately expressed in the form of their potential requirements, but since these are also required items, they will be added to the required items list for convenience sake.

The division into the above three categories and their organization into matrices are listed in the items/function deployment table of Table 2. Through this method, the deployment table, which has continued to expand by showing required quality, is made quite compact.

DEPLOYMENT TABLE OF PROGRAM UNITS

Program units are the minimum units of the program and are considered to be "constituent parts of the program." In other words, program units are, like single hardware parts such as nuts and bolts, the smallest composing units (parts) of software. Therefore, the program unit deployment table can be said to be the equivalent to the figure deploying components.

Table 2. Required Items/Function Deployment Table

Required items				Function: Input — Input by keyboard	Input — Input by disk	Record — Save	Print	Display — Display letter	Edit — Add	Edit — Move	Edit — Search	Calculate
Quality			Accurately	O		O		O	O	O	O	O
			Clear				O	O				
			Easy to see				O	O	O	O		
			Easily	O	O	O	O		O	O	O	O
			Freely	O	O	O	O	O	O	O	O	
Measures or conditions			Entirely		O	O	O	O	O	O	O	O
			Partially	O.	O	O	O	O	O	O	O	O
			On the screen					O	O	O	O	
			While opening a window		O	O	O			O	O	
			Interactively	O		O	O		O	O	O	O
System Objects	Input	Language information	Raw information	O	O			O	O	O	O	
			Required Quality	O	O			O	O	O	O	
			Quality elements	O	O			O	O	O	O	
		Design quality	Evaluation by own company	O	O			O	O			
		Added Conditions	Strength of relationship	O	O			O	O		O	
			Degree of importance	O	O			O			O	O
		Language information	Raw information			O	O	O				
			Required Quality			O	O	O				
			Quality elements			O	O	O				
	Output	Design information	Evaluation by own company			O	O	O				
		Quality deployment table	Quality table				O	O				
			Deployment table				O	O				
		Graph	Pie graph				O	O				
			Palette				O	O				

Table 3. Detailed Processing Sequence/Program Unit Deployment Table

Detailed processing sequence		Program Unit: Input — Input by keyboard — Input of letters — Hankaku (whole-size) input	Zenkaku (double-size) input	Input by disk — Text file format	CRT display — Display of letters — Hankaku (whole-size) display	Zenkaku (double-size) display	Graphics display — Display of vertical and horizontal line	Display of dots	Output — Printer output — Document printing — Printing of letters	Calculation — Calculation of sum of products — Sum of the products of the elements	
Raw information input	Display menu				O	O	O	O			Input module
	Input selection	O	O								
	Display necessary screen				O	O	O	O			
	Define input position										
	Input letter	O	O								
	Define output position										
	Display letter				O	C					
	Judge ending	O									
	Define file name										
	Write to file										
	Return to menu										
Required quality input	Display menu				O	O	O	O			Input module
	Input selection	O	O								
	Display necessary screen				O	O	O	O			
	Input selection										
	Define file name										
	Display necessary screen										
	Input selection	O									
	Define input position										
	Input letter	O	O								
	Judge ending	O									
	Write to file										
	Return to menu										
Quality element input	Display menu				O	O	O	O			Input module
	Input selection	O	O								
	Display necessary screen				O	O	O	O			
	Input selection	O									
	Define file name										
	Display necessary screen										
	Input selection	O									
	Define input position										
	Input letter	O	O								
	Judge ending	O									
	Write to file										
	Return to menu										

7. The program unit deployment table is made by breaking down the requested function into subdivisions, extracting the units which are the components of the function, and gathering them together.

SELECTION OF FUNCTION MODULES

Function modules can be defined as "the same program units which are composed with the same combination, having a single function, equivalent to function parts."

Function modules are selected from the detailed processing sequence/ program unit deployment table. This is shown in Table 3.

Conclusion

This article has presented a report on the present state of quality deployment in the Japanese software industry, centering on a case using a quality deployment support system. When seen in light of the future development of the software industry, it seems that the use of quality deployment is still quite limited. To assure software quality, quality deployment is vital, and it should be introduced in many companies developing software.

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About the Authors: Tadashi Yoshizawa is a professor in the Graduate School of Systems Management at the University of Tsukuba, Tokyo. He received his doctorate in engineering from Tokyo University. He is a member of JSQC, ASQC, and ISI.

Yoji Akao is a professor and dean in Faculty Engineering at Tamagawa University, Tokyo. He received his doctorate in engineering from Tokyo Institute of Technology. He is a member of JSQC and a past president.

Michiteru Ono is an assistant professor in Faculty Engineering at Tamagawa University, Tokyo. He received a master of science degree from Tamagawa University. He is a member of JSQC and ASQC.

Hisakazu Shindo is an assistant professor of Yamanashi University, Department of Computer Science. He received his doctorate in engineering from The Science University of Tokyo. He is a member of JSQC.

Recent Studies on Quality Function Deployment in Japan

Tadashi Yoshizawa
Professor, GSSM
The University of Tsukuba, Tokyo

Abstract

Three recent studies on QFD by research groups in JUSE and one of our projects in Graduate School of Systems Management of the University of Tsukuba, Tokyo are reported. Those studies include 1) scene" method to convert customer's verbal information to simple items of quality requirement, 2)QFD of image type to generate new ideas, 3) OMIAI meeting" of seeds and needs, 4)Quality Strategy Deployment(QSD).

1. INTRODUCTION

QFD(Quality Function Deployment) committee in JUSE(Union of Japanese Scientists and Engineers) has been established since 1988. The activities of the QFD committee are research workshops, seminars, symposium, research subcommittee as shown in fig.1.

About 80 members from various industries and universities join the research workshops every year. They belong to one of four or six subgroups and contribute to solve their group themes. The followings are the examples of the subgroup themes in the second year.

1) Methods for conversion of original verbal information into re-word data of quality requirements
2) QFD of image type for product-planners to generate new ideas
3) QFD for seeds of new material in the undeveloped markets
4) Transmission of quality information: from QA tables to QC process tables
5) Integrated QFD system
6) Computer aided QFD

The results concerned with the above themes were reported in series of "Hinsitsu Kanri" (QC Journal of JUSE) from July to December in 1990[1-6]. The first three will be shortly described in sections 2, 3, 4 of this paper respectively. The activities of the research workshops have greatly contributed to develop and promote QC technologies by synergy between the experts in industries and those in universities, as well as the other research workshops of multivariate analysis, reliability, and software quality control have done.

QFD has develcped as an useful QC method for new product development and quality assurance since 1960's in Japan. In 1972, a system of quality deployment was proposed by Akao[7] and the ideas of quality table was publicized by Nishimura of Mitsubishi Heavy Industy[8].

Since then, QFD has been widely applied as one of the most powerful methods in new product development to realize the basic ways of TQC like "market in", "customer oriented", and "lean method in product development". Beyond the use for development of hardware product, QFD has been utilized to develop service and software products[9,10,11]. We have tried to apply QFD to the problems of evaluation of corporate management and to those of deployment of quality strategies[12]. This study will be mentioned in the last section.

2. SCENE METHOD FOR QUALITY REQUIREMENT

The basic steps of QFD are the followings: quality-planning of the object of develcpment by quality requirement table; quality-design by quality chacteristics and quality tables; deployment of subsytem and functionional parts; QA tables and QC process charts.The integrated QFD system include cost deployment, enginieering deployment and reliability deployment.

The detailed steps to constract a quality requirement table are explained as follows[9]:

1) Convert customer verbal information(the customer's own words) into "re-word data" using simple expressions limited to a single meaning.
2) Group the re-word data and assign a heading that more broadly describes the data. Write this on a card.
3) Use these descriptive headings as approximately third-level details. Group these into similar categories assigning descriptive headings into first and second levels, as done in the KJ Method.
4) Clarify which are first level details of demanded quality. Adjust by adding second and third levels of detail, if necessary, to the demanded quality.
5) Assign classification numbers and organize them into a quality requirement table.

It is recognized that the direct conversion of the above step 1 is not easy, although the step is the key of success in QFD. Then, Ohfuji et al.[1,13] proposed an indirect method of conversion, which we call "scene method".

In this method, the following steps for conversion are recommended:

1) Record the customer's attribute data with the original information required to the target object of development.
2) Observe or imagine the various "scenes" where the target object are being used.
3) Derive the interim expressions between the original information and "re-word data", freely, creatively and realistically

imagining the scenes.
4) Finally express "re-word data" for each simple quality requirement.

An example of the format which was designed to execute scene method"[1] is partly shown in fig.2, where cheap lighter of ¥100 is the target.

3. QFD OF IMAGE TYPE

QFD has been mainly used for developing the products in the case that those product-concept are considerablly clear. Nishihara et al.[2] studied the processes in developing the typical hit products in Japan and found some new steps necessary to be added to standard QFD in order to dig out the customer's hidden wants and to modify the concept more creative. They name their system "QFD of image type".

The proposed steps are sorted as follows(see fig.3):
1) Suppose that a temporary quality table made by the standard steps of QFD exits.
2) Prepare the various mirrors which reflect the wants of the times. Those mirros are called reflectors. The examples of the reflectors shown in fig.3 are thosee of technology, of sense, of ethics and of economy.
3) Try to create the new scenes and the ideas concerned with the target object by reflecting the original quality table to the reflectors.
4) Evaluate and select the ideas by appropriate questionnaire survey and/or by using Reviewed Dendrogram Method[9].
5) Update the quality table.
6) Renew the product-concept.
7) Make a new planning-quality-table.

The use of reflectors might be effective to develop the new product of creative type for which the planner have to focus the changes of the world and the hidden wants that the customers do not notice by themselves, although how to find good reflectors is still a big problem to be solved.

4. OMIAI" MEETING OF SEEDS AND NEEDS

Koura and Oyaitsu group[3] has studied QFD for new product development in the case that new seeds of material and/or those of technology has been developed within corporation, but that the hidden needs have not been found. The situation is in contrast to that in the standard use of QFD where the needs exits first, then the bottle neck engineerings(BNEs) are extracted after .

They studied the successful cases in which some seeds were the starting point in development, and arranged the conceptions and ideas which came from seeds. They concluded the followings:

1) Better "OMIAI(an interview with a view to marriage)" meeting for marriage of seeds and needs is necessary. The active and aggressive efforts to find out needs to match seeds can open up a new market.

2) The QFD of inverse order is sometimes effective. Namely, the characteristics and/or structure factors of new material with high function are sorted first, then needs and/or quality requirements are extracted(see fig.4).

5. QUALITY STRATEGY DEPLOYMENT

As development of TQC, management which makes priority to quality may be referred to "Total Quality Management(TQM)" or "Managemnt by Quality (MBQ)". Then management strategies in TQC may be called quality strategies".

Management environment have substantially changed in recent years. Various problems have developed including changes in the degrees of demand on companies for positive efforts toward environment protection, messena, growing trade friction with foreign countries, etc. The way of thinking about work and the consciousness of affluence among employees and people living in the society are changing.

Therefore corporations should adapt themselves to those changes and should even innovate their corporate culture. Moreover, social evaluation measurements of corporations are changing, too.

Uchiyama[12] applied QFD to set and deploy quality strategies under the present author's guidance. We call the deployment of quality strategies QSD: Quality Strategy Deployment .

As shown in fig.5, QSD is constracted of three sets of elements and of three kinds of quality tables. Namely, three marginal sets are "management quality requirement table(MQ)" which is demanded by stakeholders(in broad sense), management characteristics table(MC)" which is used as evaluation measurements, and "quality strategies table(QS)" which includes the elements of corporate mission, visions, basic policies, market strategies, organizational and operational policies.

Three kinds of quality tables in QSD are the followings:

1) Manegement quality table of type Ⅰ (MQxMC)
2) Manegement quality table of type Ⅱ (MQxQS)
3) Manegement quality table of type Ⅲ (MCxQS)

In TQC, management philosophy, basic policies and mid- and long-range plans are formulated in order to conduct management activities by the system of "Hoshin Kanri(policy deployment)". QSD is expected to be utilized along with policy deployment.

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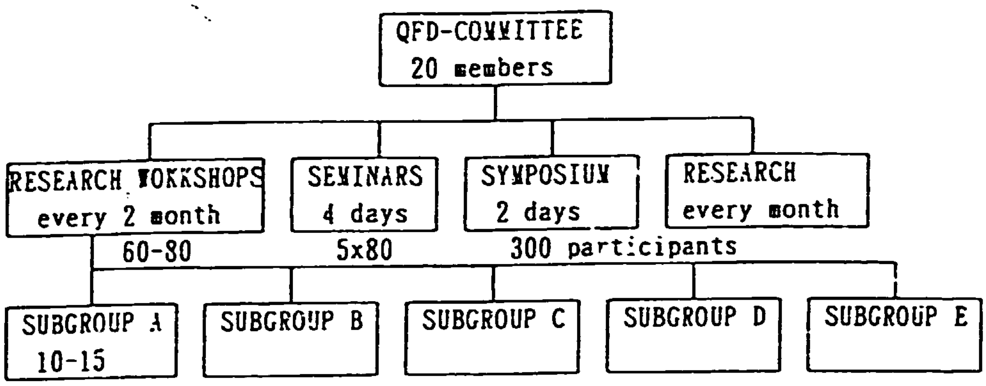


fig. 1 QFD-committee

No.	Attribute SEX AGE	original information	scene (5W1H)	interim expression	quality requirement
1	mail 21	not turned off in windy place	at bus stop in rain	can strike easily in rain and in wind even by one hand	can strike easily in rain can strike easily in wind canstrike by one hand
				stable enough	stable fire in wind

fig. 2 Part of the format for scene method

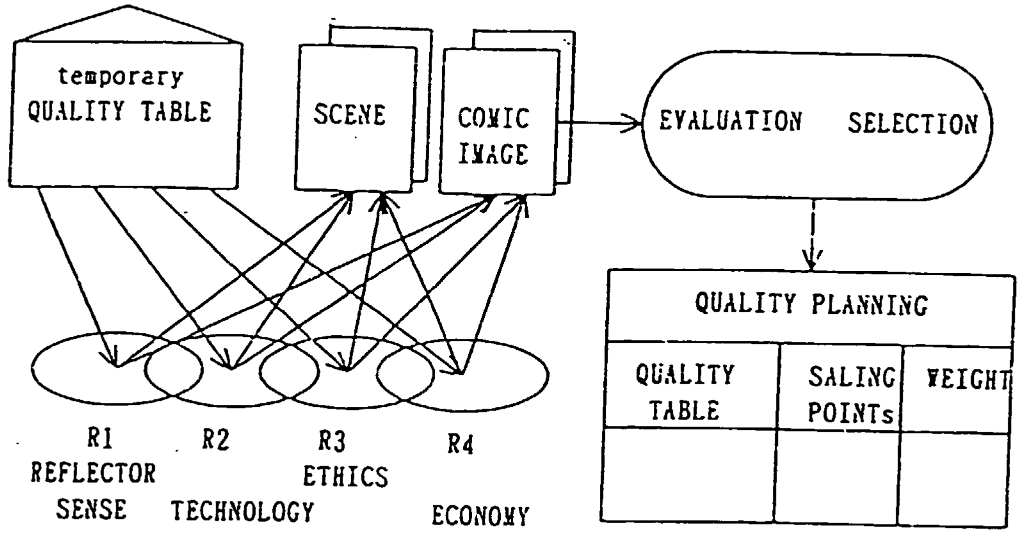


fig. 3 QFD of image type

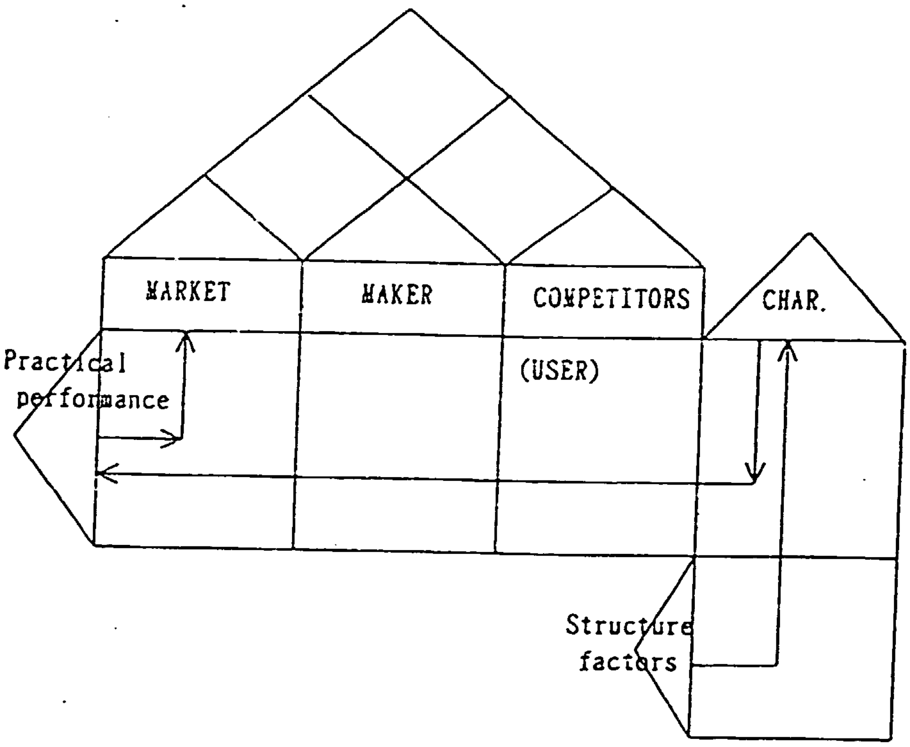


fig. 4 Inverse QFD from seed

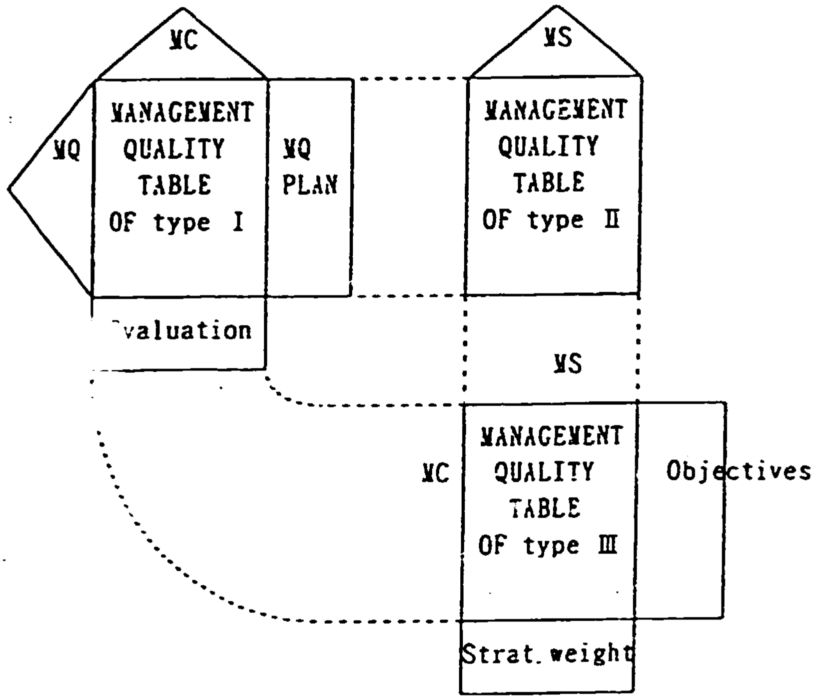


fig. 5 Core of QSD(Quality Strategy Deployment)
MQ: Management Quality Requirement Table
MC: Management Characteristics Table
MS: Management Srategies Table

2-WEEK TRAINING COURSE
FOR FCAV, BRAZIL
UNIDO PROJECT
(TF/BRA/92/B10, DP/BRA/92/004)

STANDARDIZATION

Ichiro MIYAUCHI

COUNSELOR, J U S E

UNION OF JAPANESE SCIENTISTS AND ENGINEERS

UNION OF JAPANESE SCIENTISTS AND ENGINEERS
(NIPPON KAGAKU GIJUTSU RENMEI)
5-10-11, Sendagaya, Shibuya-ku, Tokyo 151, JAPAN

STANDARDIZATION

1. GENERAL

A) It is absolutely necessary to implement quality control by every employee in every department to assure customer requirements or needs. However, to measure if customer requirements or needs are fully integrated into products or services, some sorts of definite measurable standards are required to be established for assuring for customer satisfaction.

Hereby, the standards are basic essentials in quality control and are respected and precious principles in industrial fields.

Standardization is how to establish such kinds of standards by systematic ways and how to utilize the standards effectively, which are organized by flow chart, written procedures and format for recording of processed and results.

B) **5.2 Structure of the quality system**

5.2.1 General

Management is ultimately responsible for establishing the quality policy and for decisions concerning the initiation, development, implementation and maintenance of the quality system.

5.2.2 Quality responsibility and authority

Activities contributing to quality, whether directly or indirectly, should be identified and documented, and the following actions taken :

a) General and specific quality responsibilities should be explicitly defined.

5.2.5 Operational procedures

The quality system should be organized in such a way that adequate and continuous control is exercised over all activities affecting quality.

Operational procedures coordinating different activities with respect to an effective quality system should be developed, issued and maintained to implement corporate quality policies and objectives. These procedures should lay down the objectives and performance of the various activities having an impact on quality, e.g. design, development, procurement, production and sales.

C) Kinds of Standards

(1) International Standards
- I.S.O.
- I.E.C.

(2) National Standards
- Compulsory
- Voluntary

(3) Regulatory Standards

(4) Enterprises Standards

2. OBJECTIVES OF STANDARDIZATION

The standardization is a mandatory requirements in quality assurance concepts.

A) To have quality sustaining and improvement for
- Performance and function assurance and their improvement
- Reliability and maintainability assurance and their improvement
- Safety assurance and its improvement
- Interchangeability improvement dimensionally. functionally in every component
- Replaceability improvement
- Minimum component utilization
- Uniformed quality fabrication
- Elimination of in-processing difficulty or troubles
- Recurrent trouble prevention
- Standard operation procedures establishment

B) To have cost-reduction for
- Interchangeability improvement dimensionally. functionally in every components
- Minimum component utilization
- Simplification

C) To have productivity sustainment and improvement for
- Mass-production processing design and its improvement
- Inprocess improvement
- Automation or robotic operation improvement
- Computerization operation

D) To have information/dissemination for
- Technology and skill transferring
- Customer notification (public relation, advertisement, catalogue, etc.)
- In-house notification (company's regulation, rules specification, drawings, etc.)
- Certification or qualification's justification
- Education and training
- Morale improvement

E) To have social contribution for
- Customers safety assurance
- Pollution prevention and control
- Employees safety security

3. IN-HOUSE STANDARDIZATION

In-house standards are consisted of Regulation and Specification. Regulation specifies for company's management and operation functions, and specification is for technological and technical requirement for every operational processing in each department: as

- Regulation
  - Fundamental regulation
  - Organizational and functional regulation
  - Managemental regulation
- Specification
  - Technological and technical requirement
  - Processing requirement
  - Operational requirement

These relationship and processing flow chart is explained in Fig. 1.

A) Regulation

Regulation is generally consisted of

(1) Fundamental regulations which state for

- President/founder's creeds and philosophy for company's management
- The article of association
- Rule of CEO
- Rule of board meeting
- Stock handling rules

(2) Organizational regulations which state for

- Work regulation
  - Promotion
  - Pay system
  - Ethical code
- Rule of organization
- Rule of assignment
- Rule of committees

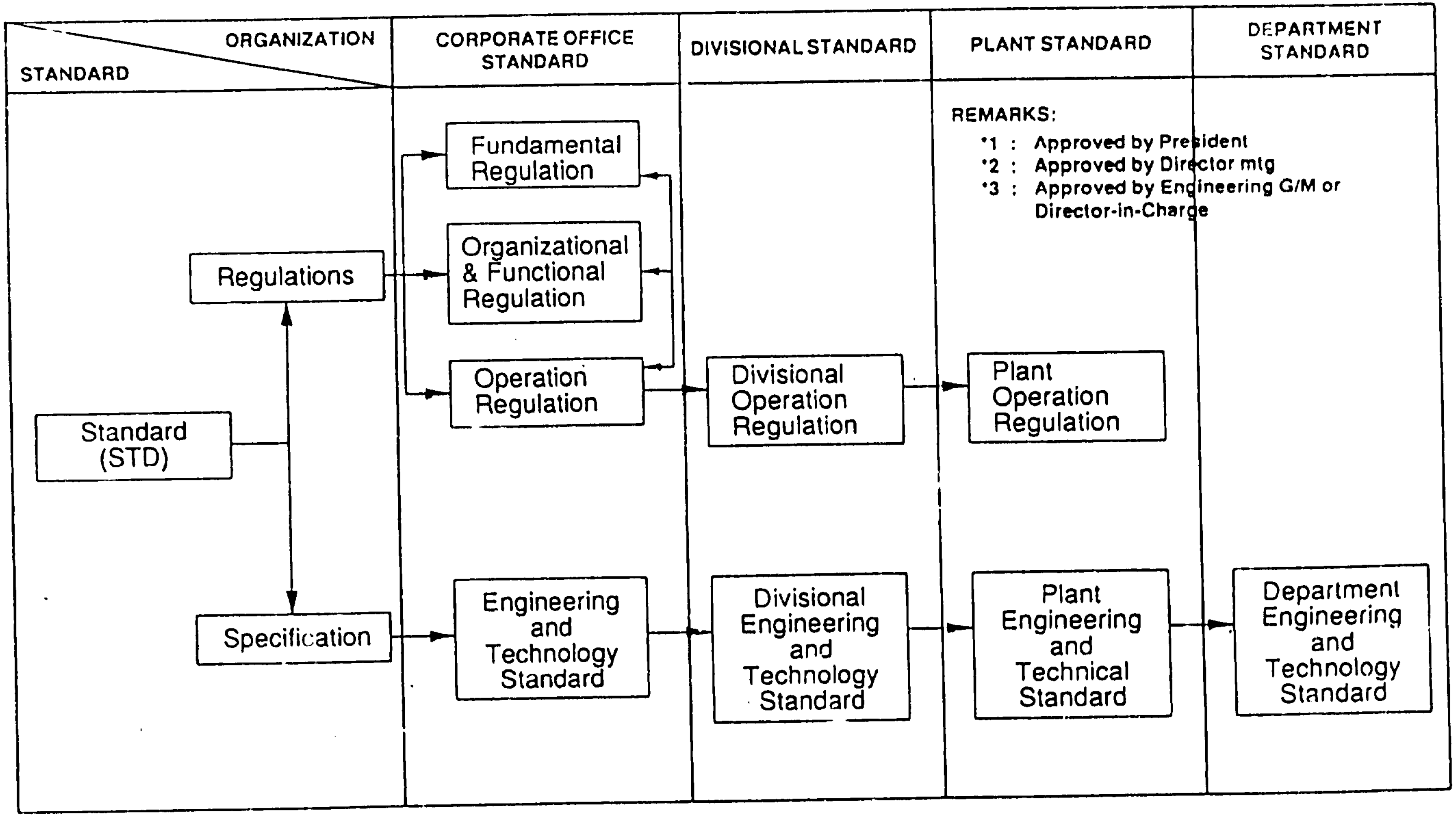


Fig. 1 Standards Establishing Flow

(3) Functional regulations

- Rule of job description statement
- Rule of General behavior
- Rule of Regulation establishment
  - Establishment
  - Approval
  - Distribution
  - Revision
  - Auditing
  - Controlling
- Rule of documentation
- Rule of education and training office function
- Rule of administration office function
- Rule of TQC office function (including QC Circle)
- Rule of personnel office function
- Rule of finance office function
- Rule of planning office function
- Rule of auditing office function
- Rule of procurement office function
- Rule of production and fabrication function
- Rule of engineering office function
- Rule of marketing office function
- Rule of quality assurance function
- Rule of pollution control office function
- Rule of industrial safety office function, etc.

(4) Management regulation

- Labor relation's regulation
- General stock-holders meeting regulation
- Senior directors meeting regulation
- directors meeting regulations
- Balance sheet preparation regulations
- Small report preparation regulations
- TQC concept implementation regulations, etc.

B) Specifications

Specifications are generally consisted of products/service standards, and operational/processing standards.

(1) Product/service specification

- Product/service specification
- Product/quality drawing
- Raw material specification
- Casting or forging drawing
- Pressing or stamping die drawing
- Test and inspection specification
- Inspection equipment, instrument, tool and gauge standards
- Engineering standards

- Drafting manual
- New product development standards
- Standardized parts/component specification, packaging or crating procedures and material standards
- Installation standards

(2) Operational/processing standards

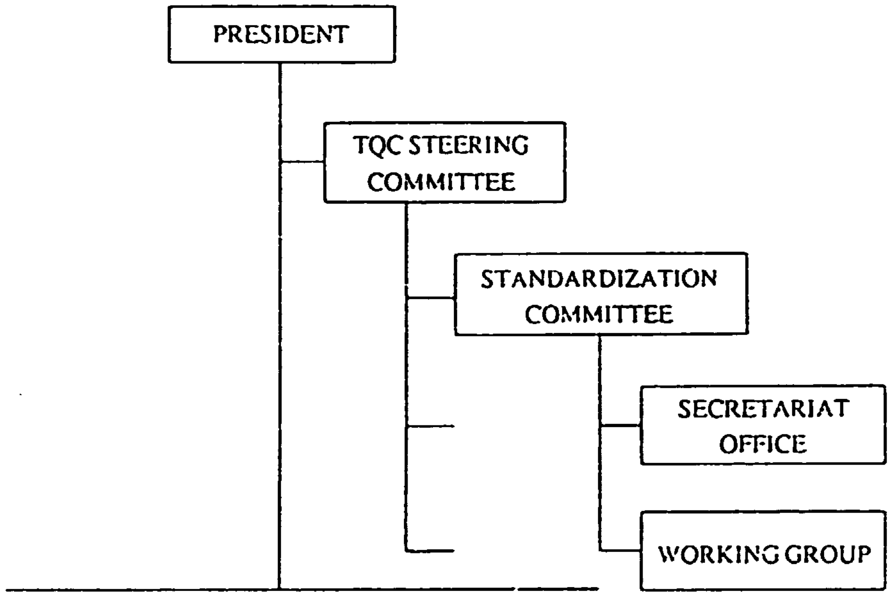
- Process analysis standards
- Special processes specification
- Standard operation procedures

  - For equipment
  - For personnel
  - For procedures
- Processing tags or slips
- Stock and inventory control instruction
- Market survey or research processing instruction
- Sales control instruction
- Transportation control instructions
- Quality information collecting, analyzing, recording, retrieval and controlling standards
- Logistic control standards

4. PREPARATION PROCEDURES FOR STANDARDIZATION

A) Installation of company-wide standardization steering committee

(1) First of all, standardization steering committee will be established under TQC steering committee. This committee is to be considered as a subcommittee of TQC as shown in the following



(2) Committee chairman: Recommend to be seated by V.P. or Sr. Director in charge of general affairs (Administration)

(3) Committee members: Management in every cross-functional organizations

(4) Secretariat office: Staff or management in administration office

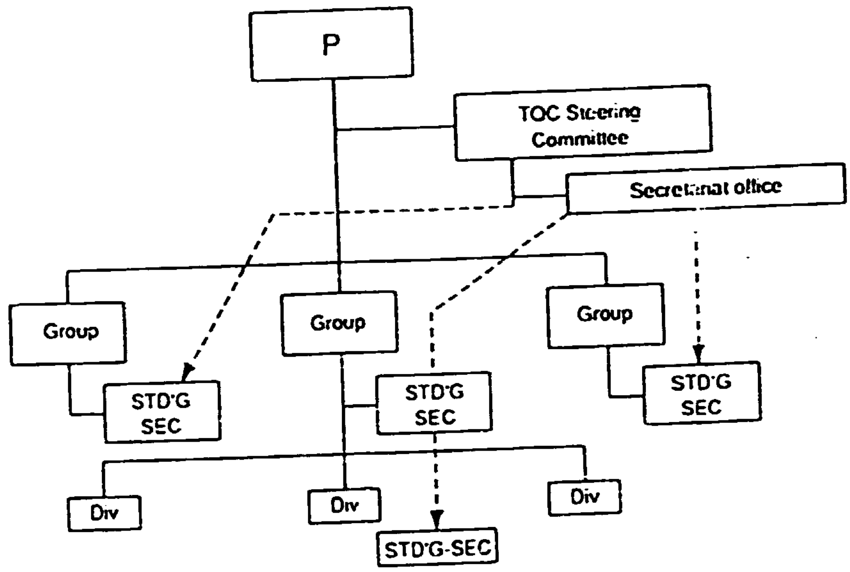
(5) Rule of steering committee

- Establish standardization promotion plannings and programs for
  - Standardization regulation establishing, planning, and dissemination, or updating programs
  - Re-evaluation of standards established for their necessity
  - Claim or complaint reduction program establishment and facilitation
  - Critical quality problem solution program establishment and facilitation
  - Establishment of production quality standard in production organizations
  - Preparation of standard operation procedures
  - Establishment of design quality standards
  - Establishment of quality evaluation standards and auditing standards
  - Establishment of company-wide quality assurance system evaluation standards

- Evaluation of standardizing processing and procedures established
- Determination of priority for establishment, revision or rescinding of every standard

B) Installation of sub-secretariat offices in higher echelon's offices

(1) After steering committee and secretariat are organized, every group, division or plant-wide secretariat offices for standardization expediting are needed to be installed as sub-secretariat/sub-sub-secretariat offices, depending on their priority, and to functionally cooperate with HQ's secretariat office:



(2) Role of sub-secretariat offices

These offices' roles are similar to the HQ's office. but they differ slightly in that they are rather software/hardware-oriented, or concentrating on routine work type standards establishment from company-wide oriented action, as shown in the following Fig. 2.

C) Standardization processing — when not fully standardized

When a company is not fully standardized yet for every operational procedures, it is better to follow as

(1) Firstly, understand top management commitment for standardization — why necessary to prepare by manager himself and disseminate to his subordinates

(2) Secondly, establish standards preparation program while consulting with his sub-or sub-sub secretariat offices within 5 years schedules.

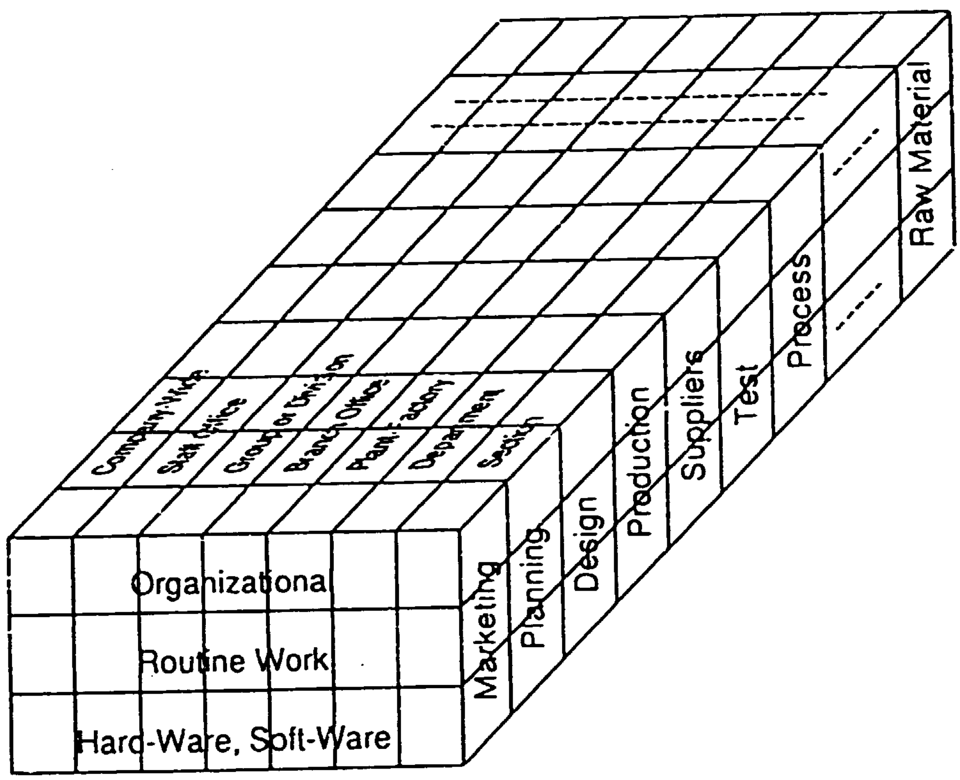


Fig. 2 Standardization Matrix For Subject Selection

(3) Thirdly, to prioritize standardization, organize brainstorm meeting with one's subordinates to identify status of standardization in his office/department for shake-down.

(4) Fourthly, evaluate the status obtained, and identify the weakness for standardization.

(5) Determine sectors necessary to establish standard with the highest priority based on customer satisfaction concept.

(6) Assign appropriate subordinates for establishing of the standards mentioned.

(7) Discuss draft standards with every subordinates for evaluation.

(8) If concurred, discuss with other related departments for coordination and pre-agreement (Nemawashi)

(9) Then submit to his superior for approval

(10) Send to the central ledgering office for numbering, distribution and matter-filing.

(11) Periodically, evaluate their effectiveness, and revise if possible, every 2 years

D) Standardization processing - already standardized

In case most of standardization has been finished.

(1) Improvement concentration

It is necessary to steadily concentrate more for improvement of standards established, based on specialization, simplification, and integration - concepts, such as

(a) Specialization

- to create more effective and economical processes or methods for specific, limited quantity production during fabrication or assembly work.

(b) Simplification

- to develop products with the least number of components or parts for assembly.
- to design product contours or shapes with more simple lines.
- to develop production processes with less processing on, or simple processing.

(c) Integration

- to use more common components or parts available in commercial shops.
- to process on more common commercial based work-shops.

(2) Timeliness concentration

When revision or improvement ideas are justified, these must be implemented as possible as one can for competitive dominancies, especially for changing of

- management policy
- organizational structure
- new product development
- suggestion proposal
- users/customers demands
- periodic survey summarization reports
- drastic upheaval forecastings
- competitors status and trends analysis

5. EVALUATION OF STANDARDIZATION

To evaluate the standardization in-house, the following 3 areas are necessary to consider.

(1) standardization promotion system and processings – time

(2) level of standards established – quality

(3) effectiveness of standards established – utilization

A) Evaluation of standardization promotion activity

(1) evaluate if standardization program is progressing as scheduled

(2) evaluate status of standardized numbers

(3) evaluate status of completion, revision or rescinding numbers

(4) evaluate how many product-models are consolidated or reduced.

(5) evaluate status of understanding and utilizing of standards established

(6) Evaluate the availability of necessary standards at every related work offices or shops

(7) Evaluate timeliness and effectiveness of establishment and revision for every standards

B) Evaluation of level of standards

(1) How many kinds of standards are established

for finished product
for component
for raw material
for auxiliary material

(2) How much communality are observed between every products

(3) How to evaluate every standard against competitors', when, who, what, how?

for policy & goal
for promotion system and structure
for promotion status
for progress status
for standards and specifications

C) Evaluation of effectiveness of standards established

In general, effectiveness formula is given as

Effectiveness = (Quantitative value + Qualitative value)
− (Standardization investment)

Where,

(1) Quantitative value = saving amount by standardization.

(2) Qualitative value = saving amount through productivity improvement, failure reduction, claim reduction, complaint reduction, service quality improvement, etc.

(3) Investment = Cost for new standards establishment, cost for condemned or retired equipment, cost for revision, etc.

However, these monitorial amounts are necessary to have cost accounting support for definite and accurate calculation that it may take sometime before calculations are finalized.

6. TIPS FOR STANDARDIZATION

During establishing of standards, it is necessary to pay attention to the following, (these are drawn out of our experiences),

A) Must be stated as action instruction, not as desire or expectation.

B) Must be clear-cut statement, and must not be misinterpreted by any personnel reading it.

C) Must not be any discretion

D) Must fit with each specific shop environment, and must be convenient for use.

E) Must be stated for inprocessing operation procedures, not for result controlling procedures.

F) Must be specified criteria for evaluation by operator himself, and must mention, when found out of criteria , what action be taken.

G) Must be easily understandable with illustrations or pictures

H) Must be revisable whenever necessary.

I) Must be traceable for revision or rescinding.

J) Must be easy to follow by any personnel.

7. QC PROCESS CHART/TABLE.

To implement "Inprocess control" concept during each processing operation, some sort of new procedures are necessary to insert into the conventional standard operation procedures (SOP).

In these new procedures such kinds of quality related informations as, every quality requirement. how to measure, how to evaluate its criteria are specified in every operation procedure as additional instruction as shown in the attached. Fig. 3 & 4, which are called as " Q.C. process chart/table".

Fig. 3 QC Processing Table (Example 1)

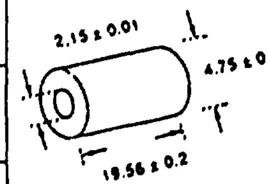
Part name: Tube				Part No. 00012222			Next Assembly No. 8015555			Change:			
Process No.	Flow		Operation Name	Machine Name and No.	Control condition		Sop No.	Measuring tool	Control procedures				Remarks
	Material	Process			Point	Criteria			Graph	Sampling	Procedures	In case of failure	
			Rough machining	Lathe L-5001	Outside Ø Inside Ø Length	5 ± 0.2 2 ± 0.5 20 ± 1	101-1	Caliper (0 - 10)	Check sheet	n = 5 (every lot)	cp	Asst. foreman	
			Semi-finish machining	Lathe L-8005	Outside Ø Inside Ø Length	4.8 ± 0.2 2.1 ± 0.2 20 ± 0.5	101-2	Caliper (0 - 10)		n = 5 (every lot)	cp	Asst. foreman	
			Finish machining	Grinding Machine g 0004	Outside Ø Inside Ø Length	4.75 ± 0.1 2.15 ± 0.01 10.58 ± 0.2	101-3	Micrometer (0 - 5)	Control chart (X-R)	n = 5 (every 2 hs)	cp	Foreman	
			Inspection				101-4	Micrometer					
			Plating	Cr-plate	Cr-Thickness ???	0.05	101-5	Thickness meter	Control chart (X-R)			Foreman	
			Inspection				101-6	Visual		100% visual insp.	cp		
			Horning	Horning Machine 11-1002	Cr-Thickness (after ground)	0.04	101-7	Dial gauge	Control chart (X-R)	n = 5 (every 2 hs)	cp		
			Inspection				101-8	Dial gauge					
			In process warehouse										

Fig. 4 QC Process Chart (Example 2)

Part Nomenclature.	Part No.	Date Issued:	Approved by:
Product Nomenclature:	Next Assy. No.	Date Approved:	Prepared by:

Flow No.	Process			Control Item			Responsible Personnel			
	Process Flow by Graph, Symbol	Kinds of Operation	Tool & Machine	Control Item	Standard Value	Production Standard	Section Chief	Eng'r	Foreman	Asst. F'man
1		Main-Shaft, Rough Machin.	#1 Lathe	Outside Ø	Ø = 50 ± 0.1	Ø = 50 ±0.1				○
2		Mid-Section, Machining-Lathe	#5 Lathe	Outside Ø, Mid-Sect.	Ø = $20^{-0.050}_{-0.060}$	Ø = 20.5 ± $^{0.1}_{0}$				○
3		Pin, Machining-Lathe	#1 Milling	Outside Ø, Pin	Ø = $15^{0}_{-0.025}$	Ø = 15.9 ± $^{0.1}_{0}$				○
4		Transport to Grinding Shop								
5		Main Shaft	#1 Grinding	Outside Ø	Ø = $20^{-0.055}_{-0.059}$				○	
6		Mid-Sect Grind, Pin Grinding	#2 Grinding	Outside Ø, Pin	Ø = $15^{0}_{-0.020}$				○	
7		Inspection	#2 Insp. Stn.			If strict control is necessary, specify.		○		
8		Transport to Buffing								

Rev. No.	Date	Revision Reason	Issued by	Appvd. by	Rev. No.	Date	Revision Reason	Issued by	Appvd. by	Rev. No.	Date	Revision Reason	Issued by	Appvd. by

8. EXAMPLES OF STANDARDS

A) Clerical office standards

(1) General Affairs	:	Inhouse Regulation & Standard Control New Product Development Customer Claim & Complaint Handling Quality Control Product Specification
(2) Organizational	:	Organization, Job Assignment, Responsibility, Authority, & Role Committee Responsibility & Role
(3) Personnel	:	Work Regulation, Qualification , Education & Training, Certification, Promotion, Wage, Regulation
(4) Finance	:	Budget, Investment, Cost Estimation, Balance Sheet Preparation, Account Settlement, Regulation
(5) Procurement	:	Supplier Control, Procurement Spec, Procurement Office Work, Cost Control, Supplier Survey, Rating, Delivery Control
(6) Marketing	:	Sales Prediction, Customer Handling, Customer Information Feedback, Market Survey Information, Warranty Clause, Market Analysis, Competitive Products Survey

B) Production related standards

(1) Product Quality Specification

(1-1) End-Product Quality Specification

(1-2) In-Processing Component Quality Requirement

(1-3) Sampling Procedure

(1-4) Quality Characteristics Measurement Procedure

(1-5) Testing Method and Accept or Reject Criteria

(2) Raw Material Specification

(2-1) Direct Raw Material Specification

(2-2) Auxiliary Material Specification

(2-3) Shelf-Item Procurement Specification

(2-4) Sub-Contracting Item Specification

(3) Test and Inspection Standard

(3-1) Testing Method Standard

(3-2) Testing Measurement Standard

(3-3) Instrument Control Procedures for Testing Equipment

(3-4) Sampling Procedure for Test & Inspection

(3-5) End-Item Final Inspection Procedure & Its Criteria

(3-6) Inprocess Inspection Procedure & Its Criteria

(3-7) Identification & Disposition Procedures for Acceptance, Rejection or Condemnation

(3-8) Special Inspection Procedure & Its Criteria

(3-9) Inspection Equipment Control Procedure

(3-10) Material Review Procedure

(4) Engineering Standard

(4-1) Engineering Processing Standard such as Conceptual, System & Detail Design Phases

(4-2) Intrinsic Engineering Principle Standard — (Mechanical, Electrical, Hydro, Etc.)

(4-3) Design Review Procedure

(4-4) Design Process Control Procedures (Time, Cost Manpower, Etc.)

(4-5) Inprocess Standard (HT, Plating, Soldering, Brazing, Welding, Etc.)

(4-6) Weight-Control Standard

(4-7) Cost-Control Manual

(4-8) Checking-Procedure Standard

(4-9) Engineers Qualification & Certification Standard

(4-10) Engineering Management System Standard

(5) DRAFTING MANUAL

(5-1) DRAWING PREPARATION MANUAL (DRAWING MATERIAL, SIZE, ETC.)

(5-2) DRAWING NUMBERING PROCEDURE

(5-3) DRAWING RELEASING, ISSUING, DISTRIBUTION, REVISION, ETC. PROCEDURES

(5-4) DRAWING UP-DATED DISTRIBUTION PROCEDURE

(5-5) MASTER DRAWING FILING MANUAL

(6) NEW PRODUCT DEVELOPMENT STANDARD

(6-1) NEW PRODUCT DEVELOPMENT DECISION PROCEDURE

(6-2) NEW TECHNOLOGY IMPLEMENTATION PROCEDURE

(6-3) MARKET STUDY AND ANALYSIS PROCEDURE

(6-4) NEW DESIGN TECHNOLOGY IMPLEMENTATION PROCEDURE

(6-5) NEW PRODUCT DEVELOPMENT TIME-SPAN & COST CONTROL PROCEDURES

(7) STANDARDIZED COMPONENT/PART STANDARD

(7-1) STANDARDIZED COMPONENT/PART ESTABLISHING STANDARD

(7-2) SELECTION STANDARD OF STANDARDIZED COMPONENT/PART

(7-3) STANDARDIZED COMPONENT/PART SPECIFICATION

(7-4) SUSTAINING STANDARD OF COMPONENT/PART SPECIFICATION

(8) OPERATION STANDARD

(8-1) PROCESS OPERATION STANDARD IN PRODUCTION PHASE

(8-2) PROCESS OPERATION STANDARD IN UTILIZATION PHASE

(8-3) OPERATION INSTRUCTION AT PRODUCTION CONTROL OFFICE

(8-4) OPERATION INSTRUCTION AT MAN-HOUR CONTROL OFFICE

(8-5) OPERATION INSTRUCTION AT PROCUREMENT OFFICE

(8-6) OPERATION INSTRUCTION AT BUDGETING OFFICE

(8-7) OPERATION INSTRUCTION AT COST ACCOUNTING OFFICE

(8-8) OPERATION INSTRUCTION AT PERSONNEL OFFICE

(8-9) Operation Instruction at Administrative Office

(8-10) Format Control Standard

(8-11) Industrial Safety Standard

(8-12) Hygiene Control Standard

(8-13) Energy Control Standard

(8-14) Education & Training Manual

(8-15) Process Instruction for Sampling

(8-16) Measurement Standard

(8-17) Calibration Specification for Test & Inspection, and Operation Equipment

(8-18) Claim & Complaint Handling Instruction

(8-19) Warranty & Guaranty Policy & Handling Instruction

(8-20) Contract and Purchase Order Handling Procedures

(8-21) Market Survey Instruction

(8-22) Market Research Instruction

(8-23) Operation Instruction at Sales and marketing Office

(8-24) Public Relations Manual

(8-25) General Advertising Control Instruction

(8-26) Sales-Campaign Manual

(8-27) Stock or Inventory Control Standard

(8-28) Operation Instruction at Logistic Office (Warehouse, Transport. Crating)

(9) Specific Function Managing Standard

(9-1) Ethical Code Instruction

(9-2) Various Committees' Management Regulation

(9-3) Employees (Including Management) Job Description (Role, Responsibility & Authority)

(9-4) Wage System Standard

(9-5) Promotion System Standard

(9-6) Personal Recruiting & Promotion Standard

(9-7) Education & Training Standard

(9-8) "Management by Policy" Instruction

(9-9) QC Circle Implementation Instruction

(9-10) TQC Implementation Instruction

(9-11) Organization & Personnel Assignment Regulation

(10) "Standards" Controlling Procedure

(10-1) Company's Regulation & Rule

(10-2) Standard & Specification Establishing Regulation

(10-3) Standard & Specification Approval Procedure

(10-4) Standard & Specification Issuance, Distribution, Revision, Rescinding, Auditing, Master Filing, Etc. Procedures

(C)T Q C RELATED STANDARDS (Examples)

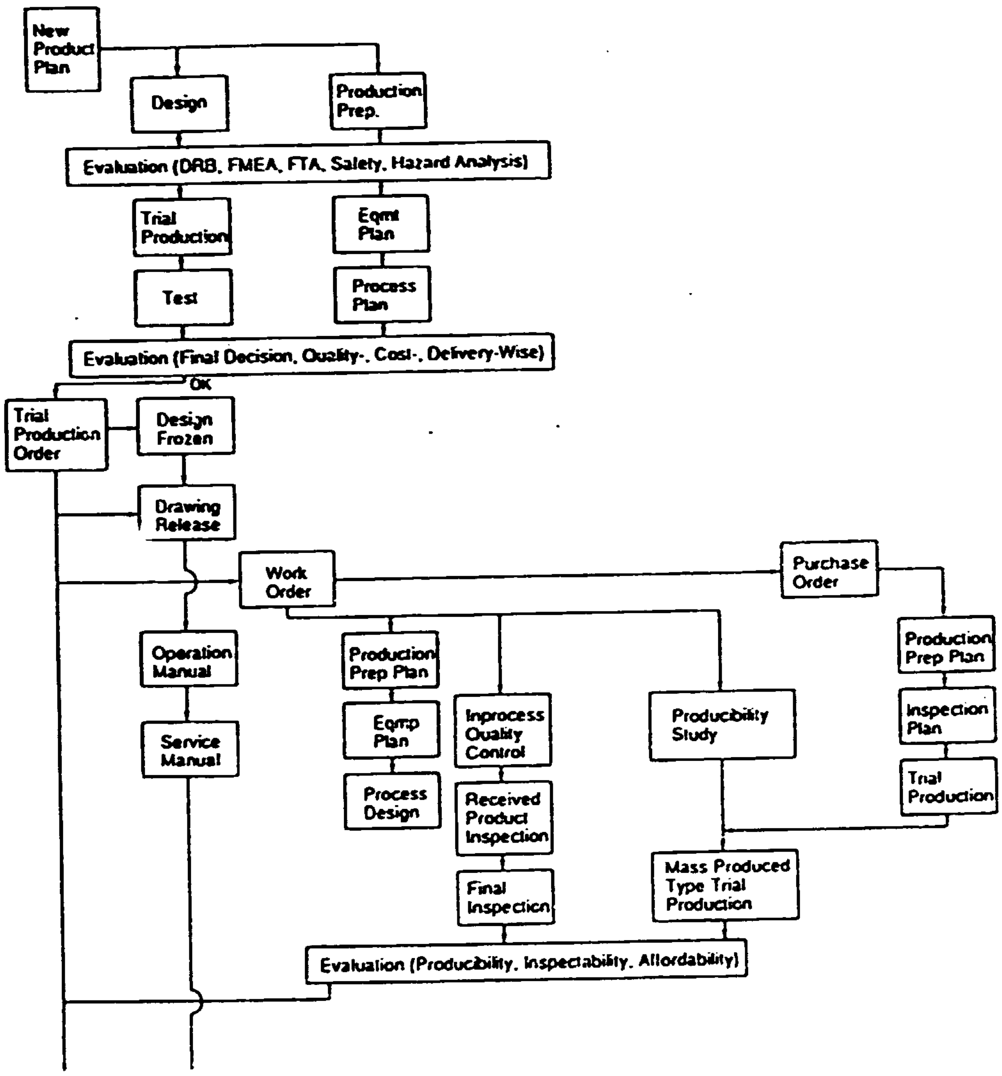
Basic Regulation: Creed, the Article of Association, Board Meeting

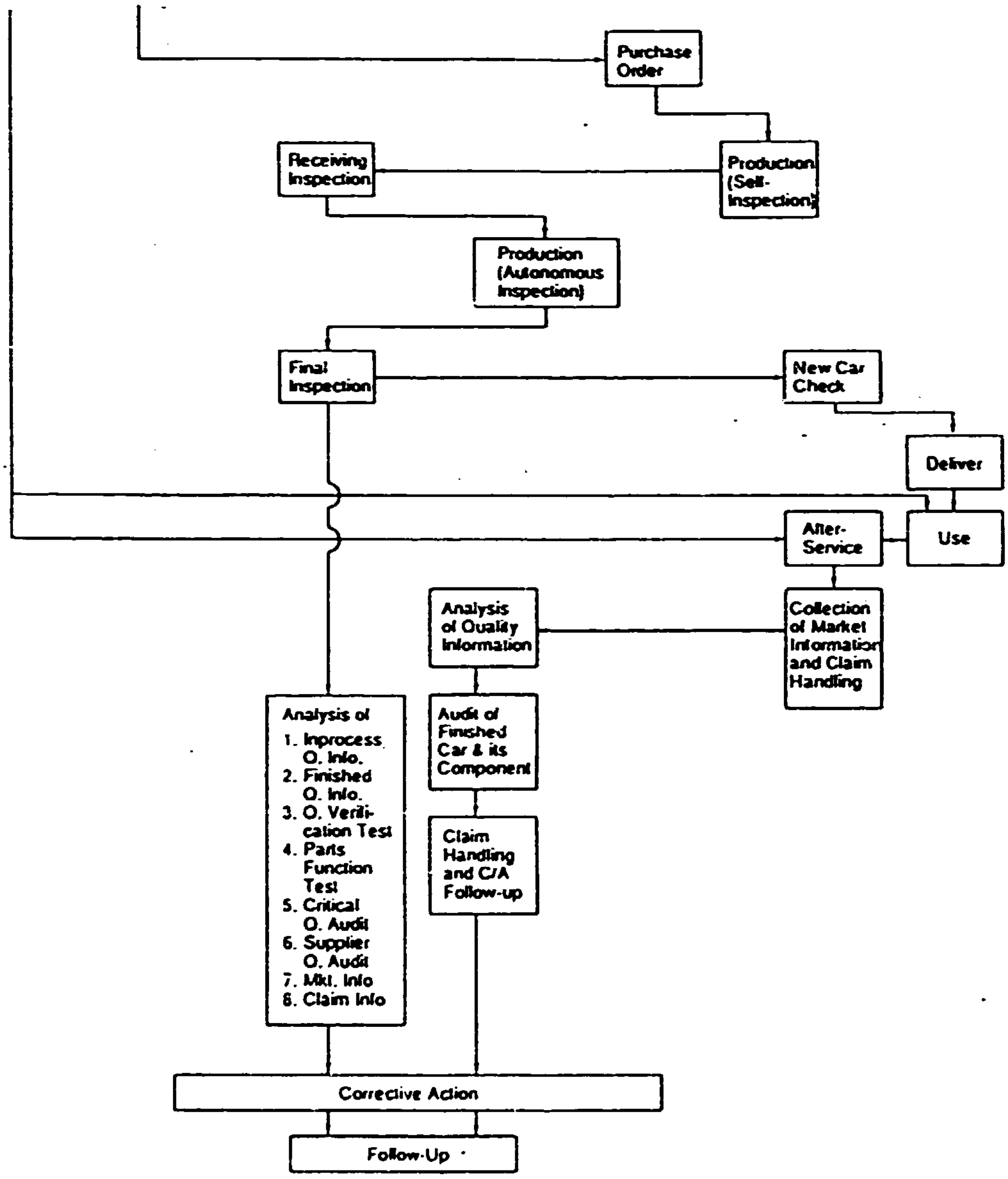
<table>
<tr><td rowspan="14">CONTROLLING RULE</td><td rowspan="4">ORGANIZATIONAL RULE</td><td rowspan="4">GENERAL</td><td colspan="2">Organization Control</td><td>Organization & Functional Control</td></tr>
<tr><td colspan="2">Job Assignment & Authority</td><td>Job Description, Ringi System, Office Responsibility.</td></tr>
<tr><td colspan="2">Committee, Meeting</td><td>Meeting, Functional Committee, TQC Steering Committee, New Product Development Committee</td></tr>
<tr><td colspan="2">TQC Organization & Delegation</td><td>TQC office, TQC Promotion Plan, TQC Management</td></tr>
<tr><td rowspan="10">WORK CONTROL</td><td rowspan="8">GENERAL CONTROL</td><td colspan="2">Quality Control-General</td><td>Quality Control</td></tr>
<tr><td colspan="2">Management by Policy</td><td>Management by Policy, Routine Control</td></tr>
<tr><td colspan="2">Management by Function</td><td>Quality Assurance, Quantity Control, Cost Control</td></tr>
<tr><td colspan="2">Controlling Flow Chart</td><td>Management by Policy, Quality Assurance, Quantity Control, Cost Control</td></tr>
<tr><td colspan="2">Education & Training</td><td>In-House Education & Training</td></tr>
<tr><td colspan="2">Standardization</td><td>Standardization, Rule & Regulation Control, Std. Spec. Control</td></tr>
<tr><td colspan="2">TQC Audit</td><td>TQC Audit QC Diagnosis</td></tr>
<tr><td rowspan="3"></td><td rowspan="3">BY STAGES</td><td>Investigation</td><td>Quality Information Collection, Market Surveying, Competitive Product Investigation, Quality</td></tr>
<tr><td>Research & Development</td><td>Analysis, Demand Forecasting, New Product Development Control, Newly Developed Product Evaluation, New Product Developing Cost Control</td></tr>
</table>

CONTROLLING RULE	WORK CONTROL	QUALITY ASSURANCE	BY STAGES	Planning	New Product Planning, New Process Planning
				Design	Design Review, Quality Deployment Drawing Control
				Procurement	Supplier Control, Subcontractor Control, Supplier Rating System, No-Inspection System
				Production	Production System, Production Control, Control-Chart Utilization Process Capability Control, Failure Report System, In-process Control, Plant Experiment, Self-Inspection System
				Shipment Store	Shipping Quality Level Control, Transportation Control, Storage Control, Corrosion Control
				Sales & Service	Marketing Control, Initial Product Control, Tech Service Control, Claim & Complaint Handling, Recall Procedure, Product Survey in Market Procedure, Customer Information Treating
			BY FUNCTIONAL	Inspection	Initial Processing & Finished Products, Inspection – Inprocess, Receiving & Outgoing, Inspection Record Reviewing Procedures
				Quality Audit	Periodic Audit Planning, Market Quality Evaluation, Long-Life Product Quality survey, Critical Quality Problem Treating Procedure
				Equipment	Equipment Maintenance, Equipment Procurement Procedure, Calibration
				Energy	Energy Control Procedure

CONTROLLING RULE	WORK CONTROL	QUALITY ASSURANCE	BY FUNCTIONAL	Quality Info Equipment	Quality Info Equipment Control. Calibration Control
				Safety	Safety & Sanitation Control
				Pollution	Environment Protection Control. Pollution Prevention Control
				Suggestion System	Suggestion System Control. Awarding System
				Office Work Control	Office Work Improvement, White Color Productivity Measurement
				QC Circle	People Building, Evaluation System, Rewarding System

D) Flow Chart (Example) for New Product Development




Purchase Order
Receiving Inspection
Production (Self-Inspection)
Production (Autonomous Inspection)
Final Inspection
New Car Check
Deliver
Use
After-Service
Analysis of Quality Information
Collection of Market Information and Claim Handling
Analysis of
1. Inprocess Q. Info.
2. Finished Q. Info.
3. Q. Verification Test
4. Parts Function Test
5. Critical Q. Audit
6. Supplier Q. Audit
7. Mkt. Info
8. Claim Info
Audit of Finished Car & its Component
Claim Handling and C/A Follow-up
Corrective Action
Follow-Up

9. STNDARDIZATION FOR NON-CLERICAL OFFICE

STANDARDIZATION

9-1. organization

EFFECTIVE MANAGEMENT FOR QUALITY MUST BE CLEARLY PRESCRIBED THRU CUSTOMER REQUIREMENT (FOR EXTERNAL CUSTOMER) / DUTY ASSIGNEMENT (FOR INTERNAL CUSTOMERS) BY EVERY MANAGEMENT ASSIGNED.
EMPLOYEES PERFORMING QUALITY FUNCTION MUST HAVE SIFFICIENT, WELL-DEFINED RESPONSIBILITY, AUTHORITY AND THE ORGANIZATICNAL FREEDOM TO IDENTIFY AND EVALUATE QUALITY PROBLEMS AND TO INITIATE, RECOMMEND OR PROVIDE SOLUTIONS. MANAGEMENT REGULARLY ARE NECESSARY TO REVIEW THE STATUS AND ADEQUACY OF THE QUALITY PROGRAM.

9–1–1 organization assessment

A. DOES THE ESTABLISHSED PROGRAM IDENTIFY THE ORGANIZATIONAL ELEMENT RESPONSIBLE FOR EACH OF THE VARIOUS QUALITY EFFORTS?

B. DO THE EMPLOYEES PERFORMING THE QUALITY FUNCTION HAVE SU– FFICIENT AUTHORITY, RESPONSIBI– LITY, AND FREEDOM OF ACTION TO IDENTIFY AND EVALUATE QUALITY PROBLEMS AND INITIATE, RECOM– MEND, OR PROVIDE SOLUTIONS ?

C. DOES MANAGEMENT PERICDICALLY REVIEW THE STATUS, TRENDS, AND ADEQUACY OF THE QUALITY PRO– GRAM, THAT IS, RESULTS OF PER– FORMANCE AND FUNCTION ACHIEVED AND STANDARDS EFFECTIVENESS ?

9–2. initial quality planning

EVERY MANAGEMENT ARE NECESSARY TO CONDUCT COMPLETE REVIEW OF CUSTOMER OR OWN'S DUTY REQUIREMENTS TO IDENTIFY AND MAKE TIMELY PROVISION FOR THE SPECIFIC CONTROLS, PROCESSES, TEST EQUIPMENTS, FIXTURES, TOOLING AND SKILL REQUIRED FOR ASSURING QUALITY THIS INITIAL PLANNING WILL RECOGNIZE THE NEED AND PROVIDE FOR RESEARCH, WHEN NECESSARY, TO UPDATE ASSURING PROCEDURES SUCH AS CHECKING, INSPECTION AND TESTING METHODOLOGY, INSTRUMENTATION, AND CORRELATION OF INSPECTION AND TEST RESULTS WITH OPERATING METHODOLOGY AND PROCEDURES.

THIS PALNNING ARE ALSO COVERING APPROPRIATE REVIEW AND ACTION TO ASSURE COMPATIBILITY OF PRODUCTION, OPERATION, CHECKING, INSPECTION, TESTING, AND DOCUMENTATION.

ONE OF THE MAIN OBJECTIVES OF THE INITIAL PLANNING IS TO IDENTIFY ANY SPECIAL REQUIREMENTS.

9-2-1 initial planning assessment

A. DO EVERY MANAGEMENT CONDUCT A COMPLETE REVIEW TO IDENTIFY AND PREPARE FOR SPECIFIC OR UNUSUAL CUSTOMERS OR DUTY REQUIREMENTS ?

B. DO EVERY MANAGEMENT PERFORM INITIAL QUALITY PLANNING AS EARLY AS POSSIBLE ?

C. DO PLANNINGS CONDUCT ANY SPECIAL STUDYING AND RESEARCH NEEDED FOR DEVELOPING EVERY NECESSARY ADVANCED OR INNOVATED CHECKING, INSPECTION OR ASSURING TECHNIQUES IDENTIFICATION ?

D. HAS ANY ACTION BEEN TAKEN TO MAKE THE CONTROL FOR SPECIFC REQUIREMENTS COMPATIBLE THRUOUT EVERY PROCESSINGS ?

9–3. OPERATION INSTRUCTIONS

THE QUALITY PROGRAM MUST ASSURE THAT ALL WORK AFFECTING QUALITY FOR HARDWARE, SOFTWARE AND HUMAN-WARE ARE SPECIFICALLY PRESCRIBED BY CLEAR AND COMPLETE DOCUMENTED INSTRUCTIONS OF A TYPE APPROPRI-ATE TO THE ENVIRONMENT AND CIR-CUMSTANCES. SUCH INSTRUCTIONS ARE NECESSARY TO PROVIDE THE CRITERIA FOR PERFORMING THE OPERATIONS AND MUST BE COMPATIBLE WITH ACCEPTAN-CE CRITERIA FOR WORKMANSHIP.

THE INSTRUCTIONS ARE INTENDED TO SERVE FOR SUPERVISING, CHECKING, INSPECTING AND MANAGING FUNCTION.

THE PREPARATION AND MAINTENANCE OF AND COMPLIANCE WITH OPERATION INSTRUCTIONS ARE REQUIRED TO BE MONITORED AS A FUNCTION OF " QUALITY " PROGRAM.

9–3–1 OPERATION INSTRUCTION ASSESSMENT

A. ARE DOCUMENTED OPERATION INSTRUCTIONS AVAILABLE AND USED FOR ALL WORK OPERATIONS WHICH AFFECT QUALITY ?

B. ARE SUCH OPEATION INSTRUCTIONS COMPLETE AND APPROPRIATE ?

C. ARE COMPARISON STANDARDS SERVED AS THE QUALITATIVE CRITERIA AVAILABLE FOR EACH OPERATION WORK-SHOPS ?

D. ARE OPERATION INSTRUCTION COMPATIBLE WITH ASSOCIATED OR RELATED OPERATIONS(UPPER OR DOWN STREAM WORK-SHOPS) ?

E. DO EVERY OPERATORS, SUPERVISORS AND MANAGERS MAKE PROPER USE ?

F. ARE INSTRUCTION REVIEWED ON A SYSTEMATIC BASIS ACCURACY, COMPLETENESS AND COMPLIANCES ?

9–4. RECORD

EVERY MANAGEMENT ARE NECESSARY TO MAINTAIN AND USE ANY RECORD OR DATA ESSEBTIAL OT THE ECONOMICAL AND EFFECTIVE OPERATION OF THEIR QUALITY PROGRAM.

RECORDS ARE CONSIDERED ONE OF THE PRINCIPLE FORMS OF OBJECTIVE EVI-DENCE OF QUALITY THAT THE QUALITY PROGRAM ARE NECESSARY TO ASSURE FOR RECORDS ARE COMPLETE AND RE-LIABLE ENOUGH FOR HIGH CONFIDENCE LEVELS.

INSPECTION, TESTING, AND CHECKING RECORDS ARE, AS A MINIMUM, INDICATE THE NATURE OF THE OBSERVATIONS TOGETHER WITH NUMBER OF OBSERVA-TIONS MADE AND THE NUMBER AND TYPE OF DEFICIENCIES FOUND.

ALSO, RECORDS FOR MONITORING WORK PERFORMANCE AND FOR ASSURING WORK ARE INDICATING THE ACCEPTABILITY OF OPERATION AND OUTPUTS AND ACT-ION TAKEN IN CONNECTION WITH DE-FICIENCIES. THE QUALITY PROGRAM ARE PROVIDING FOR THE ANALYSIS AND USE OF RECORDS AS A BASIS FOR MANAGEMENT ACTION.

9-4-1

RECORDS ASSESSMENT

A. ARE THERE RECORDS OF ALL ESSENTIAL ACTIVITIES ?

B. ARE RECORDS AVAILABLE TO ANY NECESSARY ORGANIZATIONS FOR REVIEWAL OR EVALUATION ?

C. ARE THERE EFFECTIVE MEANS FOR ASSURING THE CURRENCY, COMPLETENESS, ACCURACY AND OPERATORS COMPLIANCY OF RECORDS ?

D. DO QUALITY ASSURANCE RECORDS INCLUDE ONLY THE NUMBER AND KIND OF DEFECTIVES ?
IS OTHER ESSENTIAL DATA RECORDED ? HOW AND WHERE ?

E. DO QUALITY ASSURANCE RECORDS AND OPERATION INSTRUCTION COMPLIANCE RECORDS INDICATE THE QUANTITATIVE DEGREE OF ACCEPTANCE OR REJECTION ?

F. IF REJECTION IS RECORDED, DO RECORDS SHOW RESULTING ACTION?

G. DO MANAGEMENT ACTIONS REFLECT THE ANALYSIS & USE OF RECORD ?

2–WEEK TRAINING COURSE

FOR FCAV, BRAZIL

UNIDO PROJECT

(TF/BRA/92/B10, DP/BRA/92/004)

PROCESS CONTROL

Hideo YOSHIKAWA

INTELLECT CO., LTD.

UNION OF JAPANESE SCIENTISTS AND ENGINEERS

UNION OF JAPANESE SCIENTISTS AND ENGINEERS
(NIPPON KAGAKU GIJUTSU RENMEI)
5–10–11, Sendagaya, Shibuya–ku, Tokyo 151, JAPAN

Simple Method for Improving Process Management

Hideo Yoshikawa, Intellect

****

Many people want to find an easy-to-understand, simple way to solve, in a short period of time, process problems such as the need for later adjustments, excessive defects,failure to increase production, and low equipment working ratio.

The examples I will introduce here illustrate one such solution. I hope that readers will apply this method to their work and be able to see actual results.

****

Example 1: Company R

1. The Incentive

Section Head Fujimoto was worried because he has been unable to raise the production of the caulking line shown in Figure 1, which processes car parts, to 159 units per hour.

He received the following advice from a consultant:

(1) Record the processing time per item during one hour of continuous operation and all problem items that occurred during that time.

(2) Create a cumulative graph of processing time and number of items processed.

(3) Create a progress followup chart on improvements made in response to problem items, and continue instituting improvements.

(4) Begin processing again and, as with the first time, record each item for one hour. Then create a cumulative graph to confirm any improvement that has been made, and continue with further improvements.

(5) Repeat the above steps several times.

Section Head Fujimoto immediately implemented the method outlined above.

2. Observation and Recording of Data, Creation of Cumulative Graph

The data, which was gathered continuously for one hour using a stopwatch and includes the processing time for each individual item processed on the caulking line as well as the problem items that occurred during that period, was recorded in Table 1.

Using the data from Table 1, the continuous data measuring time was plotted on the horizontal axis and the sequence in which the items were processed was plotted on the vertical axis to create the cumulative graph shown as Figure 2.

(Note) The data shown in Table 1 differs from that used to create the cumulative graph.

3. Creating an Improvement Progress Followup Chart and Instituting Improvements

Section Head Fujimoto created an improvement progress followup chart as shown in Figure 2 showing a) items to be implemented, b) things already implemented, c) things learned, and d) what to do from now on. The way work was performed previously was arranged in Table 1 and Figure 2 and, after discussing matters with the individuals involved, items were entered in the chart.

Through this process, Section Head Fujimoto learned the following:

1) In contrast to the target of 159 units per hour, Figure 2 showed that actual production was 89 units, making the actual working ratio an extremely low of 56%.

2) The cause was not the standard production time, but problems with equipment (insufficient supply of chucks, loaders, and work, robot malfunctions, etc.).

3) Problems with equipment also were resulting in short stoppages of the line due to rattling and incorrect positioning caused by things like loose bolts and abrasion.

4) The causes of the above problems were then classified into problems that could be solved immediately and problems that would require more time to solve. Improvements were then undertaken.

4. Observation and Recording of Data Following Improvements, Creation of Cumulative Graph

As with the first time, people observed the line and recorded data, then created a cumulative graph (Figure 3). This made the results of the improvements clear. However, there were still problems remaining, so he decided to continue making improvements.

5. Summary

Section Head Fujimoto discovered that the above method required very little time for the necessary observation and that quick improvements were achieved when everyone worked together. He therefore standardized the methodology and applied it to a variety of problems, with excellent results. Eventually, even the way that Section Head Fujimoto's subordinates provided guidance to others began to change.

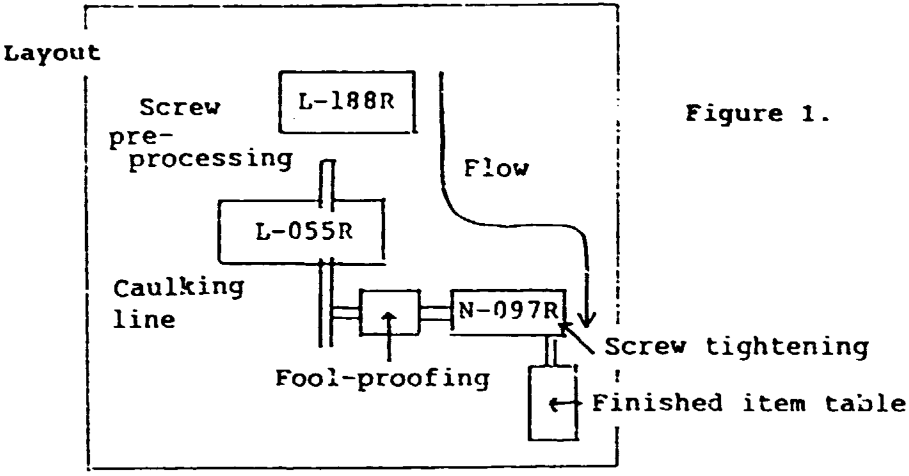


Figure 1.

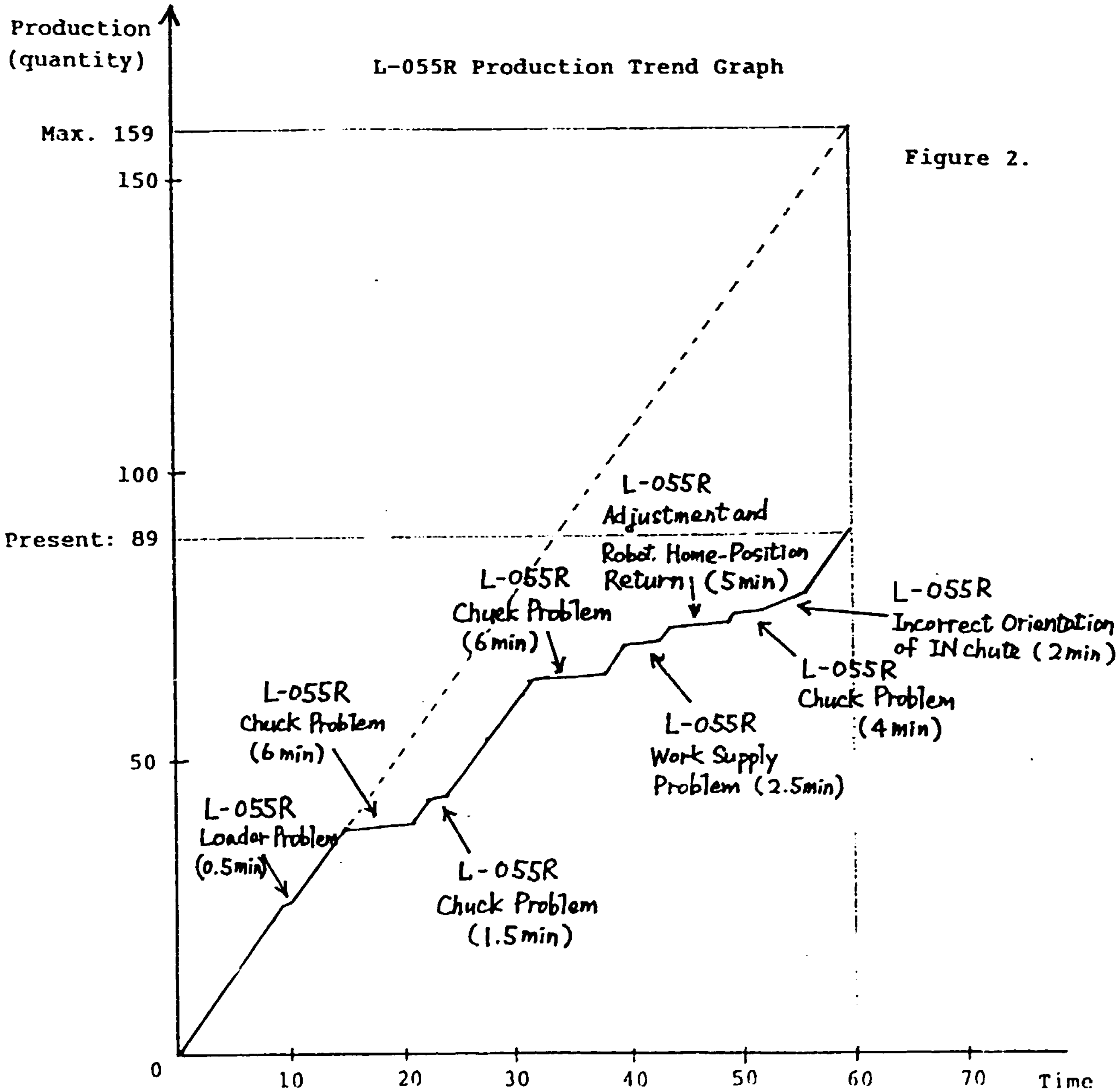


Figure 2.

Figure 3.

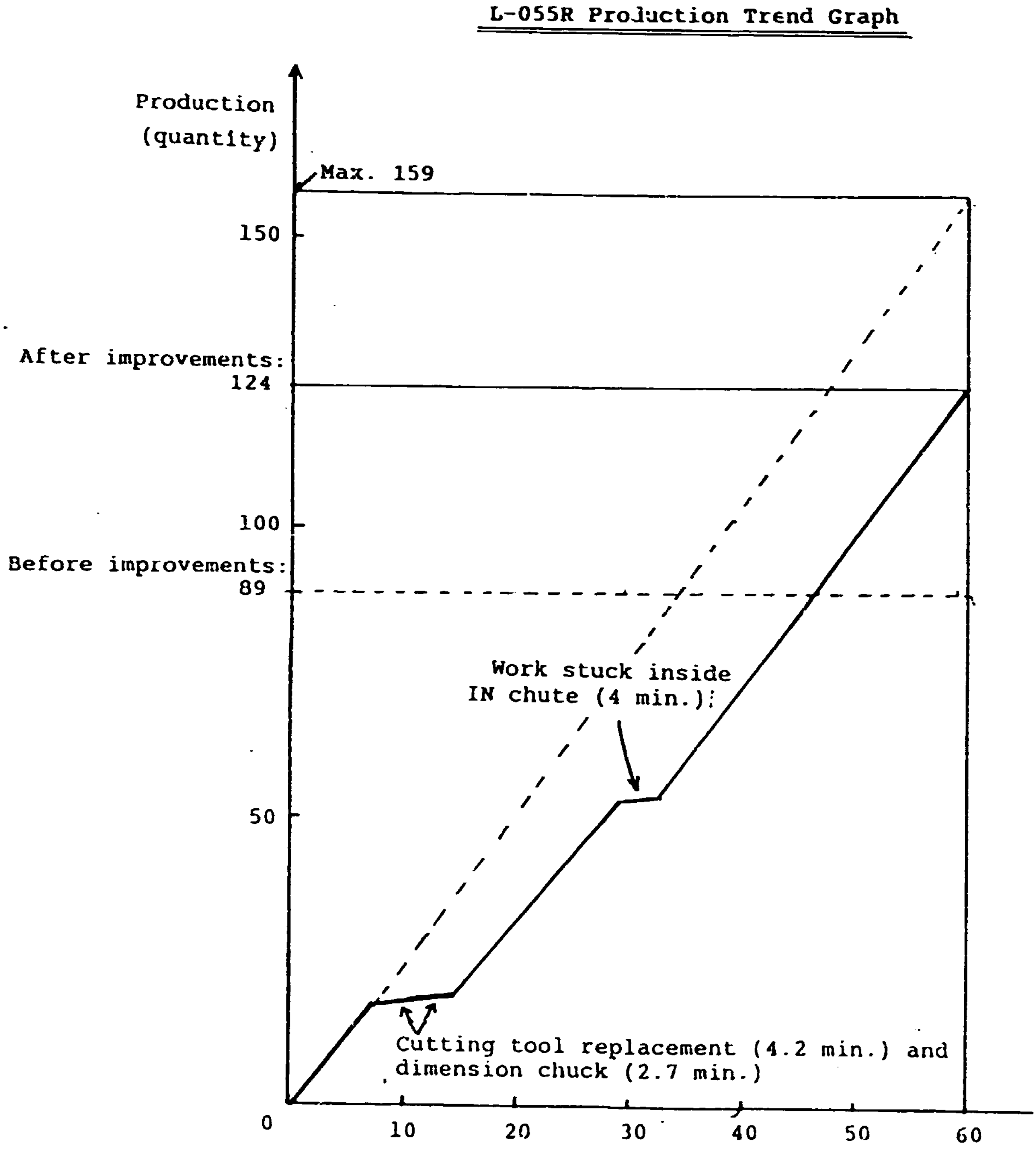

L-055R Production Trend Graph
Production
(quantity)
Max. 159
150
After improvements:
124
100
Before improvements:
89
50
0
Work stuck inside
IN chute (4 min.)
Cutting tool replacement (4.2 min.) and
dimension chuck (2.7 min.)
10
20
30
40
50
60

Table 1. Implementation example 1

Base Survey Table

Date: ____________
Name of person performing measurements: ____________
Name of operator: ____________

Line:	Automobile model:
Equipment: NC lathe	Part:
Equipment no.: L-055R	Process: Caulking
Previous process: L-188R	Standard time:

(L-067R caulking depth insufficient)

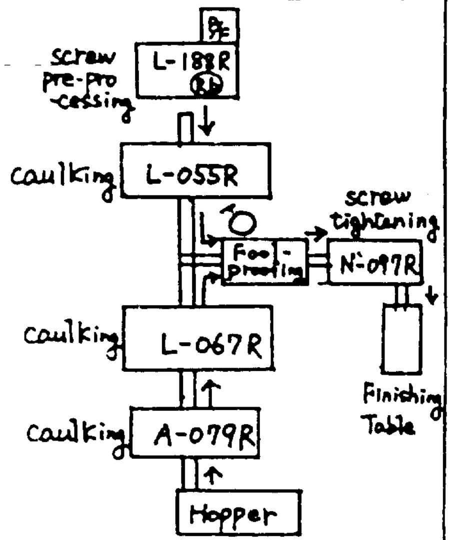
No.	Continuous measuring time	Differential	* Notes	No.	Continuous measuring time	Differential	* Notes
1	0			21	9.477		
2	0.376			22	9.861		
3	0.754			23	10.240		
4	1.140			24	10.616		[2]
5	1.516			25	(15.875)		[3]
6	1.894			26	(22.161)		[4]
7	2.278			27	22.445		
8	4.545		[1]	28	22.815		
9	4.922			29	23.192		
10	5.307			30	(23.581)		
11	5.685			31	23.953		
12	6.060			32	24.331		
13	6.444			33	26.453		[5]
14	6.823			34	26.834		
15	7.200			35	27.209		
16	7.583			36	28.836		[6]
17	7.961			37	29.218		
18	8.329			38	29.593		
19	8.723			39	29.973		
20	9.100			40	30.352		

* Notes: (Write down description of problem)

[1] L-055R work supply problem during loader advance
[2] Restart after dimensional check by workers
[3] Fool-proofing -- stop due to continuous defects
[4] L-055R work supply problem
[5] L-055R work supply problem
[6] L-055R work supply problem

Table 2. Activity progress followup chart

Item: Y32 type INR-S processing line production increase

Items to be implemented P	Things already implemented D	Things learned C	What to do from now on A
* Hokko Line Production Survey ① (L-188R ~ L-055R)  Hokko Line Layout	• The Production of L-055R was observed continuously for 1 hour, and the results were graphed (enclosure) Sept. 6 (Tue) • The Cycle time per unit was calculated based on the results of the production survey Sept. 6 (Tue) • The time consumed in short line stoppages was calculated based on the results of production survey Sept. 6 (Tue)	• Production in 1 hour of continuous operation : 89 units According to an estimate based on the graph, if the line operated continuously without any stoppages, maxium production would be 159 units per hour. Consequently, the working ratio is $\frac{89 \text{ units/hour}}{159 \text{ units/hour}} = 56.0\%$ • Cycle time per unit : 0.380 min./unit (22.8 sec./unit) • Time consumed in short line stoppages: L-055R : 26.2 min. L-188R : 0 min.	• How many goals needed ? Goal : 112 units/hour (Production for August : 93 units/hour) • Investigate nature of L-055R short line stoppages
	• The details of the short line stoppages were investigated Sept 6. (Tue)	• Classification of types of short line stoppages (a) L-055R chuck problems (including return & adjustment) 4 times (22.1 min.) (b) L-055R loader chuck failure 1 time (2.6 min.) (c) Incorrect orientation of work inside L-055R IN chute 1 time (1.5 min.)	• Investigate details of the items (a) ~ (c).

Example 2: Yamato Kogyo Corporation

1. The Incentive

Yamato Kogyo is a manufacturer of press-processed parts for automobiles. An important issue for manufacturers of press-processed parts is increasing the number of strokes (number of items processed) per minute.

Yamato Kogyo had been working on this problem for many years. However, many of the processes, such as the press processes and --especially -- the transfer processes, involved simultaneous processing and conveyance, with repetitions every two to three seconds. This meant that there were many problems that could occur, such as problems with the molds, conveyor equipment, pressing equipment, and processing conditions. To deal with this situation, a system called the "minuki" method ("minuki" or "spotting problems" is the term used by Yamato Kogyo to refer to the system they developed). It involves the use of a large number of persons to observe the line, spot problems as they develop, and institute improvements. Using the "minuki" method Yamato Kogyo was able to increase the number of strokes per minute by a whopping 50%. This method has also been applied at Nissan Yamato Engineering Ltd. (NYEL), a British affiliate of Yamato Kogyo, where a similar level of improvement was achieved.

2. Example

The enclosure entitled "How to Proceed with 'Minuki' Activities" lists the steps that need to be instituted as well as including some illustrative, some forms and graphs. In this example also, the time per stroke and the problem items are recorded as data. Then a cumulative graph is created and the problem items are listed on a table of line improvements items. Improvements are then implemented. In this example, the loss time before improvements were made of 50 minutes was reduced to 20 minutes following improvements.

Example 3: Company N

The Incentive

Company N is a manufacturer of auto parts. Due to later adjustments and equipment stoppages on its automated part assembly line, it has not been possible to increase the number of units produced per day. The company was forced to use overtime and start a new manual assembly line in order to maintain the required production volume.

In the base a variety of attempts at improvement had been made, but they had not been very effective. The company therefore resolved for the first time to use QC based improvement activities this time around.

Example

1. Process and Product

   The worker, positioned in front of the rotating assembly machine shown in Figure 2, puts the product shown in Figure 1 into the machine at step 1 and removes it at 11st.

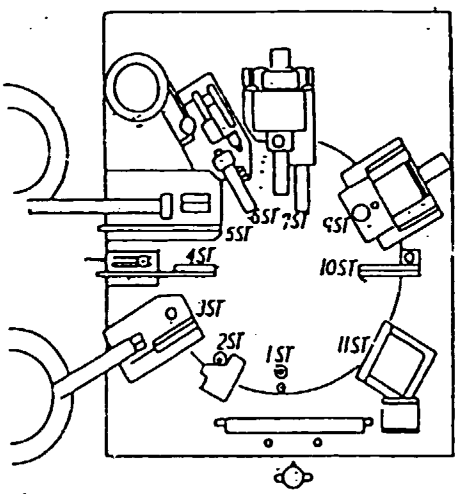


Figure 2

1st: Position part
2st: Sheet presence/absence check
3st: Pre-cup mounting
4st: Screw hole oil application
5st: P-cup mounting
6st: Sheet mounting
7st: Partial screw tightening
8st: ----
9st: Screw tightening
10st: Total length measurement
11st: Removal of good part

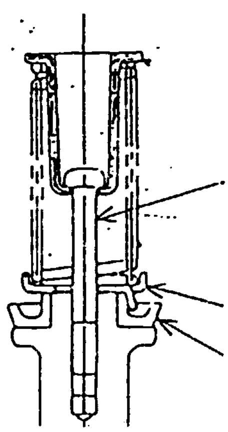


Figure 1

2. Goal

Average production for October - December 1993
252 (units/hour) = 1,767 (units/day)

20% increase

By April 1994
300 (units/hour) = 2,100 (units/day)

3. Guidance meeting with Mr. Yoshikawa

3-1 First session -- October 4, 1993

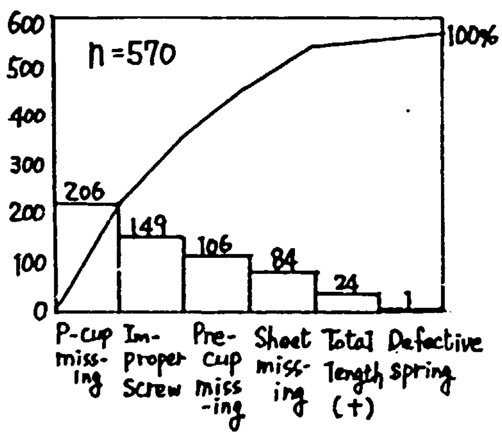
Us: We examined the S-26 line and found out that there are a large number of problems (parts that must be adjusted later or scrapped).

Mr. Yoshikawa: Clarify the problems resulting in parts that must be adjusted later or scrapped. Also take a good look at what's in the red box.

3-2 Second session -- November 19, 1993

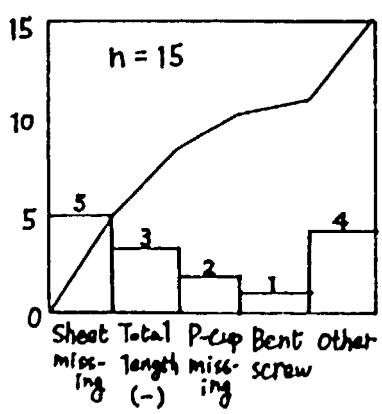
Us: We examined the number of occurrences of various types of problems during the ten days the line was operating between November 1 and November 11.

(Figure 3-2/1) Pareto Diagram of Defects Requiring Later Adjustment



Defect	Process	Number	Cause
Pre-cup missing	3st	106	·Improper advance inside part feeder ·Error due to clogged cup presence/absence sensor at tip of linear feeder
P-cup missing	5st	206	·Improper positioning of cup presence/absence sensor on piston side ·Malfunction of sheet presence/absence sensor proximity switch
Sheet missing	6st	84	
Total Length	10st	24	(Frequent inconsistency) ·Driver not operating
Total		570	11/1 ~ 12 (production quantity: 13831 units) defect ratio: 4.12%

(Figure 3-2/2) Pareto Diagram of Defects Resulting in Scrapping



(Table 3-2/2) Causes of defects resulting in scrapping

Name of Defect for scrapping	Process	Number	Cause
P-cup missing	5st	2	·Improper advance inside part feeder ·Error due to clogged cup presence/absence sensor at tip of linear feeder
Total Length (-)	10st	3	(Frequent inconsistency) ·Electrical method of defecting assembly dimentions results in consistency
other		4	
Total		15	11/1 ~ 12 (production quantity: 13,831 defect ratio; 0.11%)

Mr. Yoshikawa: Percentages and numbers of occurrences alone do not provide a clear picture. Take a good look at what is actually going on. Videotape the line and look to see what is happening. Don't rush ahead with countermeasures. Collect data first.

Table 3-3-0

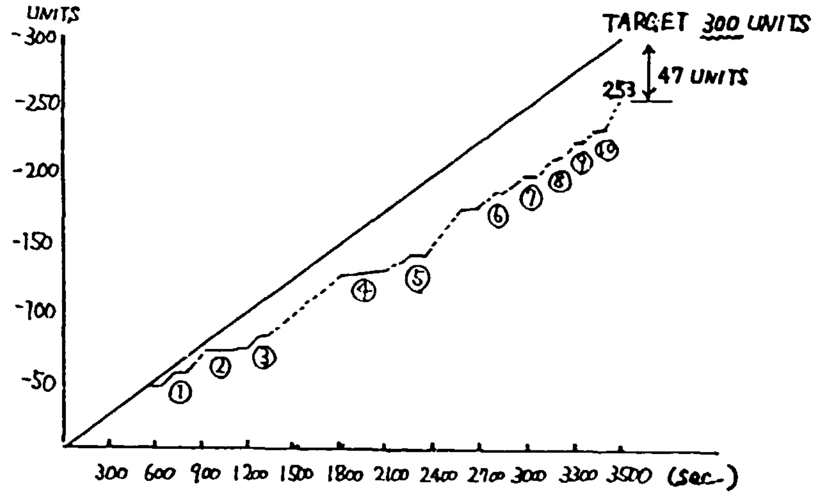
Video observation data sheet

WORK No.	TIME (sec.)	CUMULATIVE TOTAL (sec.)	OCCURRENCE ITEM	WORK No.	TIME (sec.)	CUMULATIVE TOTAL	OCCURRENCE ITEM	WORK No.	TIME (sec.)	CUMULATIVE TOTAL	OCCURRENCE ITEM
1	12	12		41	12	492		81	12	1259	-
2	12	24		42	12	504		82	32	1303	Supply Problem
3	12	36		43	12	516		83	12	1315	
4	12	48		44	12	528		84	12	1327	
5	12	60		45	12	540		85	12	1339	
6	12	72		46	12	552		86	12	1351	
7	12	84		47	12	564		87	12	1363	
8	12	96		48	24	600	Part supply	88	12	1375	
9	12	108		49	12	612		89	12	1387	
10	12	120		50	12	624		90	12	1399	
11	12	132		51	12	636					
12	12	144		52	12	648		120	12	1759	
13	12	156		53	12	660		121	12	1771	
14	12	168		54	12	672		122	12	1783	
15	12	180		55	40	724	Supply Problem	123	12	1795	
16	12	192		56	12	736		124	12	1807	
17	12	204		57	12	748		125	124	1943	Supply Problem
18	12	216		58	12	760		126	12	1955	
19	12	228		59	12	772					
20	12	240		60	12	784		144	12	2171	
21	12	252		61	12	796		145	39	2222	Mounting Problem
22	12	264		62	12	808		146	12	2234	
23	12	276		63	12	820					
24	12	288		64	12	832		248	12	3540	
25	12	300		65	12	844		249	12	3552	
26	12	31		66	12	856		250	12	3564	
27	12	324		67	12	868		251	12	3576	
28	12	336		68	12	880		252	12	3588	
29	12	348		69	12	892		253	12	3600	
30	12	360		70	12	904					
31	12	372		71	12	916					
32	12	384		72	12	928					
33	12	396		73	223	1163	Incorrect home position				
34	12	408		74	12	1175					
35	12	420		75	12	1187					
36	12	432		76	12	1199					
37	12	444		77	12	1211					
38	12	456		78	12	1223					
39	12	468		79	12	1235					
40	12	480		80	12	1247					

3-3 For the one hour (3,600 seconds) shown on the video, the time per item was measured and the problems that occurred along the way were recorded on a data sheet (Table 3-3-0).

The cumulative graph based on the cumulative times recorded in this data is shown in Figure 3-3-1. It shows that many equipment stoppages occurred during the hour and that this is an obstacle to productivity. In addition, the reasons for permanent countermeasures to deal with the problems are listed in Table 3-3-1.

(Figure 3-3/1) Data Recorded During One Hour of Observation on December 10



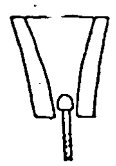
(Table 3-3/1) Equipment Failures

No.	OPERATON	STOP TIME	OCCURRENCE	ACTION	REASON	COUNTERMEASURE.
1	6st : Supply screw	40s	Supply problem	Screw supplied from rail to rotating platter	Sensor doesn't turn on because screw is missing from rotating platter	Redesign rotating platter
2	1st : Drive section	223s	Incorrect home position	Return to home position at 1.3. 6. and 7st	Exist of photo-electric tube as safety device in case operator's hand get inside during operation	Watch out for workers
3	6st : Supply screw	32s	Same as 1	Same as 1	Same as 1	Same as 1
4		124s				
9	7st : Partial screw tightening	58s	Screw mounting problem	Ignor parts not mounted	Screw not in hole	Redesign jig
10	3st : Cup mounting	20s	Cup mounting problem	Supply cup to rail		Clean Rail
TOTAL		639s	6st - 271s, 1st - 223s, 6st - 67s, 7st - 58s, 3st - 20s			

Mr. Yoshikawa: View the video over and over. All of you should watch it together. Decide on precise times for inspecting and cleaning the part feeders and rails.

3-4 Fourth session -- February 25

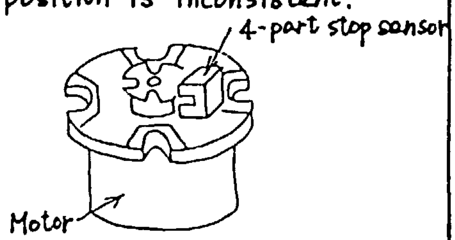
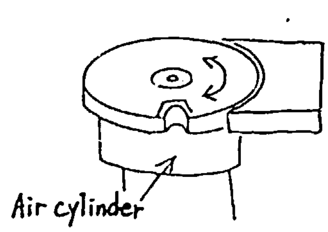
Us: We have refined the problem items further through extensive observation and data collection and decided to make corrections one by one. We reduced stoppage time in step 7, resulting in an improvement.

Before improvement	After improvement	Result
Screws often become stuck in the guide when being supplied.  screw head diameter: $\phi 6^{+0}_{-0.5}$ guid hole diameter: $\phi 6$	Guide hole widened to ϕ 6.1.	Screws never get stuck anymore.

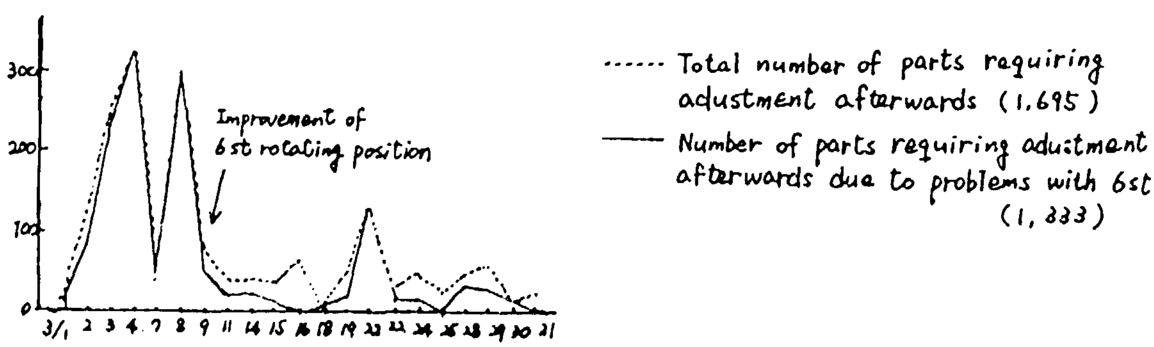
Mr. Yoshikawa: Give some thought to how much of a problem short stoppages are for the workers. We need to reduce short stoppages some more. Take another look at the revolving portion.

3-5 Fifth session -- March 22

Us: We improved the supply of screws (rotating portion) in 6st.

Before improvement	After improvement	
Due to the electric motor, the screw supply index stopping position is inconsistent. 	An air cylinder is now used to rotate the index. 	The index now stop in correct position.

(Figure 3-5/2) Trend in Number of Occurrences of Parts Requiring Adjustment Afterwards in March 1993



The number of parts requiring adjustment afterwards dropped following the change from an electric motor to an air cylinder. However, there are still problems with 6st.

Mr. Yoshikawa: Define the problems that need correction more precisely. Classify the screw problems more carefully.

3-6 Sixth session -- May 30

Us: We did a detailed classification of screw mounting problems.

(Table 3-6/1) Detailed Classification of Screw Mounting Problems

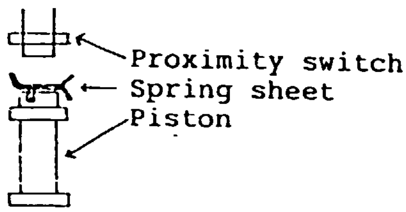
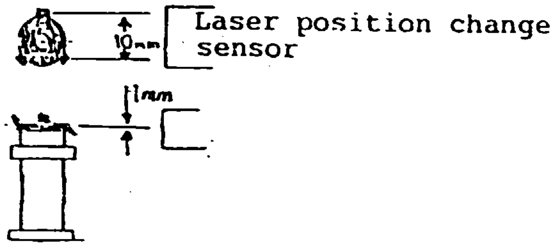
6st screw supply problem
[1] Rotating table doesn't operate. (1) Screw not supplied to part feeder. (2) Screw gets stuck inside part feeder. (3) Electrical fault of unknown origin. (4) Screw present/absent sensor not functioning on rotating table.
[2] Doesn't enter screw guide. (1) Screw isn't chucked and is dropped instead. (2) After chucking, screw doesn't go into screw guide and instead flies outside.
[3] Screw stuck inside screw guide. (1) Defect in shape of screw head. (2) Tip of screw guide bends during operation, causing screw to get stuck.
[4] Position switches malfunctioning. (1) Bad timing. (2) Position switch doesn't turn on.

Though we did a detailed classification, we were still unsure as to how to proceed. We then performed centering on the various parts of 6st and 7st.

Mr. Yoshikawa: If you do too much messing around with each little part, things are liable to slip out of alignment. The more fiddling around you do with instable areas, the more causes of instability there will be.

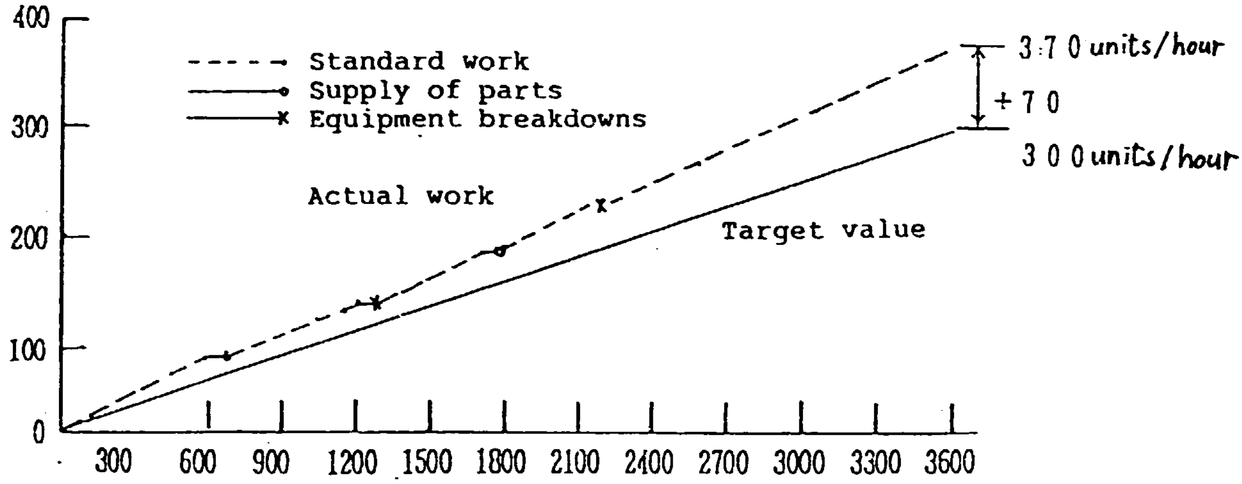
3-7 Seventh through ninth sessions

We and Mr. Yoshikawa had a question and answer session to look at the process and discovered the real points that needed improvement. Of the various improvements we decided on, the following are typical.

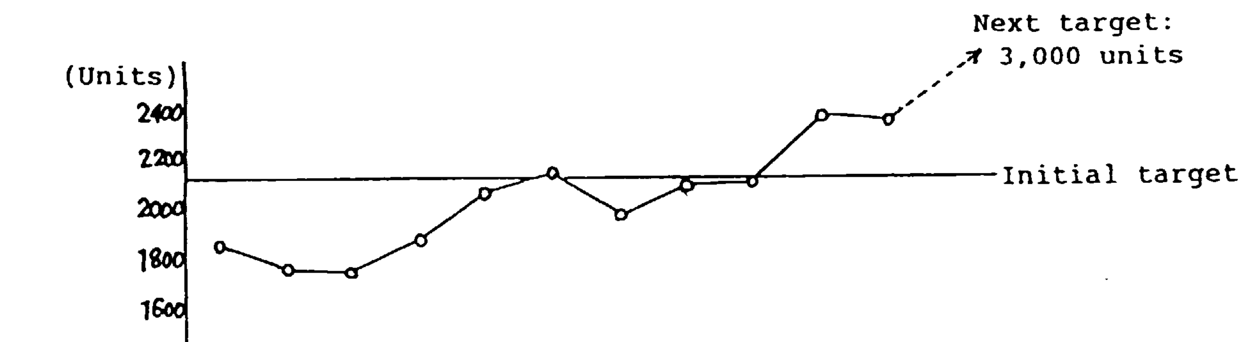
Before improvement	After improvement
In step 6 we were using a proximity switch to detect the presence or absence of the spring sheet. This worked fine when an aluminum piston was used. However, when a steel piston was used, the flow would mistakenly go on to the next one even when a spring sheet was present. This resulted in faulty units lacking sheets. 	Errors were eliminated through the use of a laser sensor. The sensor is 10 mm wide, so the spring sheet is detected no matter what its orientation.  In August, there were no cases of faulty units lacking sheets. Also, we attached a cover to the lens to prevent it from becoming dirty due to splattered oil. The cover is normally kept closed.
Since the presence or absence of parts is determined using optical fibers in the various steps, there are often errors caused by oil or dust (except in the case of the spring sheet).	By switching to an optical switch, we eliminated short line stoppages. (Oil, dust, etc., are not detected.)

4. Results

Short stoppages observed on December 20, 1993: 10/hour
Short stoppages observed at latest check: 2/hour



(Figure 4-1) July 25, 1994 -- Record of Observation of One Hour of Video



Year/month	93/10	11	12	94/1	2	3	4	5	6	7	8
Production volume	1847	1737	1727	1853	2040	2112	1941	2077	2085	2379	2357

(Figure 4-2) Average Daily Production Between October 1993 and August 1994

Result

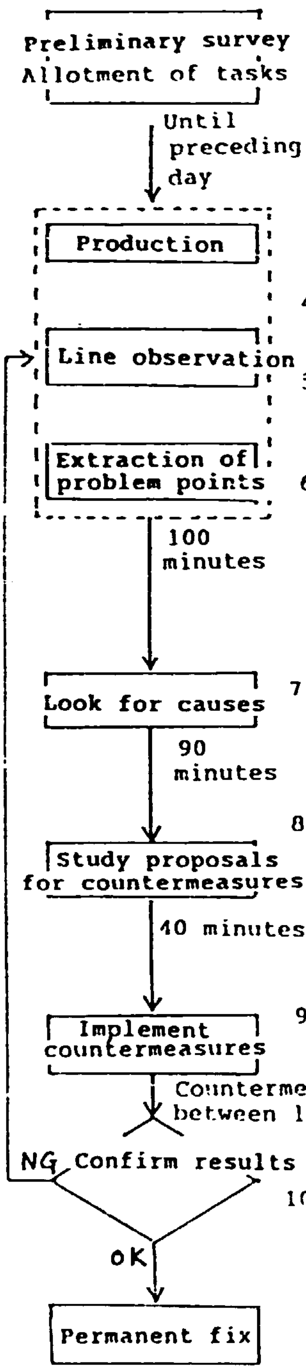
1. Production volume: Average between October 1993 and December 1993
--1,767 (units/day) = 252 (units/hour)
29% increase
↓
Average between June 1994 and August 1994
-- 2,272 (units/day) = 325 (units/hour)

2. Number of units scrapped due to later adjustments: Reduced approximately 400 (units/month) (2.8% -> 1.6%)

3. Intangible results: The line used to stop all the time, making the workers nervous and causing them to want to go home early. Now there are few line stoppages and the workers are very pleased.

4. Permanent fix: The line's "3s" has been optimized and the machine receives regular maintenance.

5. Impressions:
Mr. Yoshikawa's guidance not only allowed us to eliminate problems and make improvements, it also allowed us to isolate the true causes of our difficulties by examining the facts over and over from different angles. At first we were confused, but now we plan to continue this activity and are setting 3,000 units as our next goal.



1. Selection of affected parts
   * Production result calendar for each part (1)
   * Setting SPM distribution table for each part (2)
   * Table of part specifications (3)
2. Confirm planned production date.
3. Set allotment of tasks, confirm ahead of time.

* Record the number of strokes and problem items at each stage on the (4) stroke data sheet.

4. Everyone observes the processes they are in charge of and pinpoints problems.
   * Write down on Post-It labels (4).
5. Record cumulative strokes from beginning to end of production and the problems arising at each stage.
   * Make cumulative stroke graph and record occurrence of problems (6).
6. Arrange problem points for entire line.
   * Arrange information from (4) and (6) on process breakdown problem point table (5).

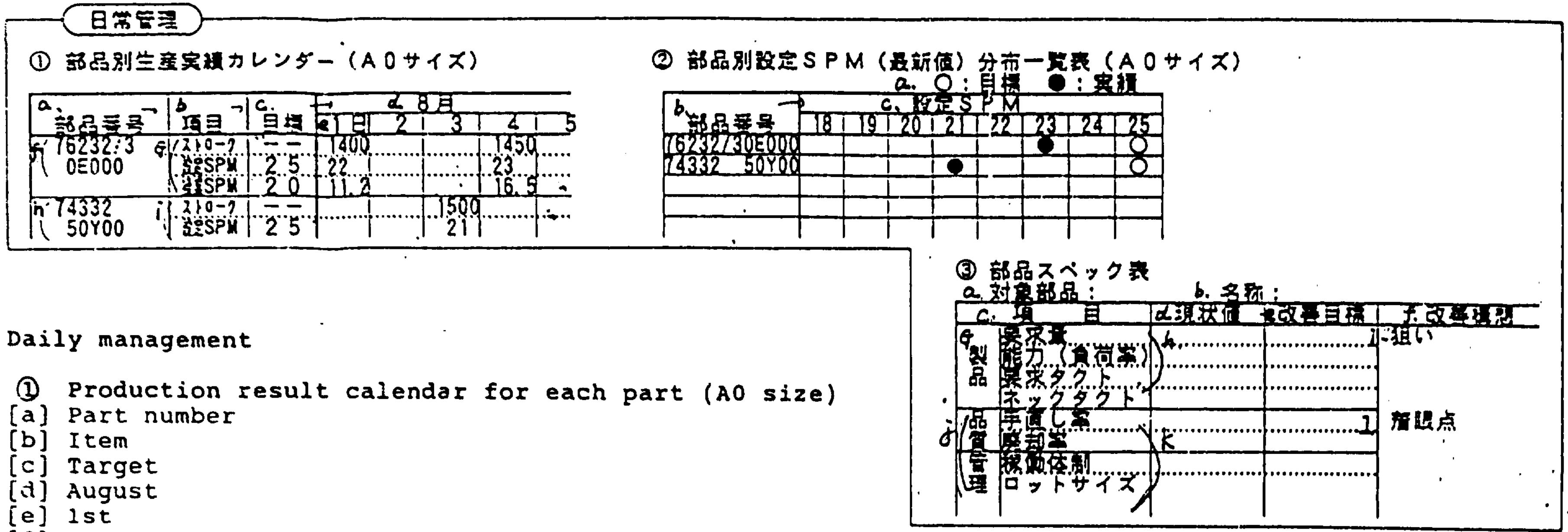
7. Confirm assumed causes against conditions on site.
   * Record causes on process breakdown problem point table (5).

8. Study proposals for countermeasures.
   * As a general rule, study countermeasures and decide persons in charge and schedules at the scene.
   * Summarize the above countermeasures on the line improvement item table (7) (pinup diagram and A3 size).

9. Implement countermeasures through next lot.
   * Proceed from line improvement item table (7).

10. Confirm results of countermeasures when producing next lot.
    * Confirm elimination of problems based on line improvement item table (7).
    * Confirm results by creating a cumulative stroke graph (8) after implementation of countermeasures.

11. Provide feedback through daily management documents.
    * Revise the SPM distribution table for each part (2).
    * Revise and issue standards and specifications of various types.
    * Follow up on future results using the production result calendar for each part (1).



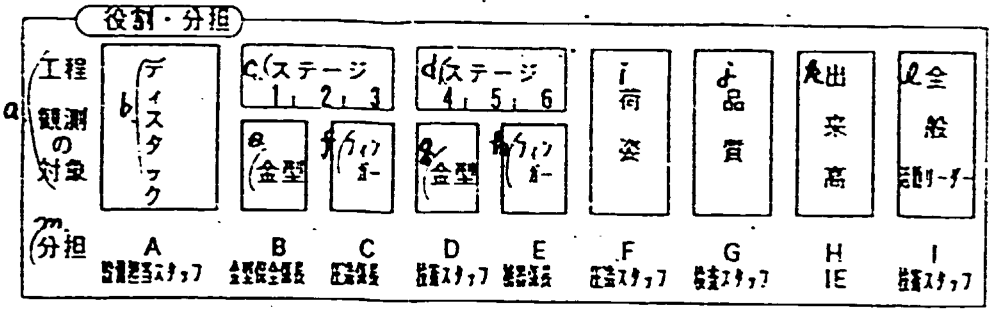
Daily management

① Production result calendar for each part (A0 size)
[a] Part number
[b] Item
[c] Target
[d] August
[e] 1st
[f] 76232/3
0E000
[g] Strokes
Set SPM
Actual SPM
[h] 74332
50Y00
[i] Strokes
Set SPM

② SPM (latest values) distribution table for each part (A0 size)
[a] Target
Actual result
[b] Part number
[c] Set SPM

3 Part specification table
[a] Affected part
[b] Name
[c] Item
[d] Present value
[e] Improvement goal
[f] Improvement concept
[g] Product
[h] Requested volume
Capacity (load ratio)
Requested standard time
[i] Goal
[j] Quality management
[k] Later adjustment ratio
Scrapping ratio
Activation system
Lot size
[l] Points noticed

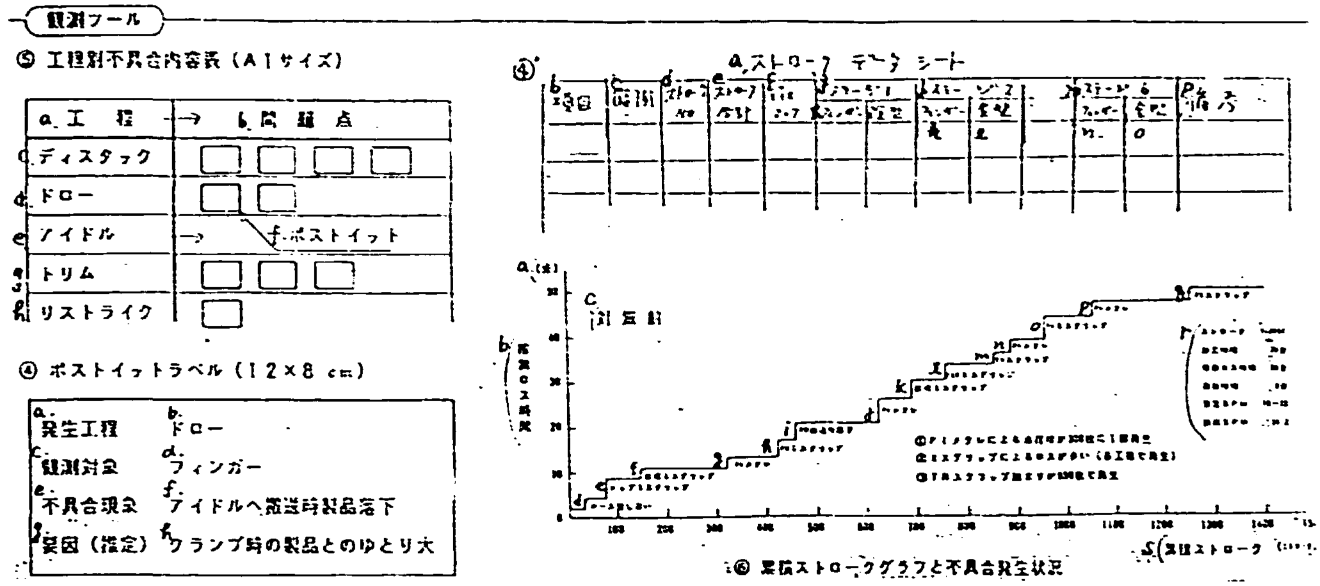
Allotment of tasks



[a] Process to be observed
[b] Distack
[c] Stages
[d] Stages
[e] Mold
[f] Finger
[g] Mold
[h] Finger
[i] Packing
[j] Quality
[k] Production volume
[l] Overall activity leader
[m] Allotment

A
Equipment staff
B
Mold maintenance clerk
C
Pressing clerk
D
Technical staff
E
Machinery supplement
F
Pressing staff
G
Inspection staff
H
IE
I
Technical staff

Observation tools



⑤ Process breakdown problem point table (A1 size)

[a] Process
[b] Problem points
[c] Distack
[d] Drawing
[e] Idle
[f] Post-It
[g] Trimming
[h] Re-striking

④ Post-It labels (12 x 8 cm)
[a] Process of occurrence
[b] Drawing
[c] Observation target
[d] Finger
[e] Problem
[f] Product drops during transport to idle
[g] Cause (supposed)
[h] Too much looseness when clamping product

④'
[a] Stroke data sheet
[b] Item
[c] Time
[d] Stroke no.
[e] Stroke total
[f] Distack
[g] Stage 1
[h] Finger
[i] Mold
[j] Stage 2
[k] Finger
[l] Mold
[m] Stage 6
[n] Finger
[o] Mold
[p] Notes

⑥ Cumulative stroke graph and problem occurrence status

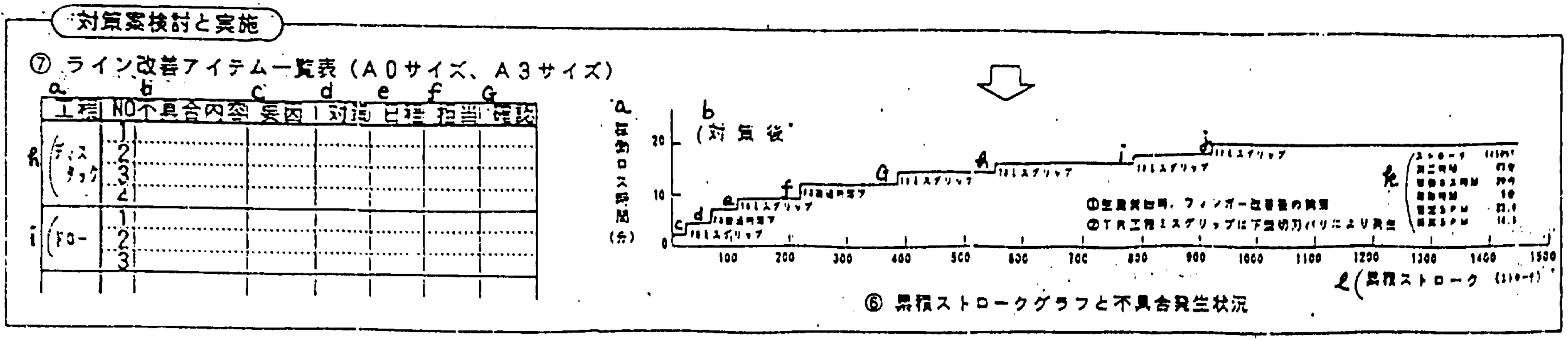
[a] (Minutes)
[b] Activation loss time
[c] Before countermeasures
[d] Incorrect hose insertion
[e] Top mis-grip
[f] Mis-grip
[g] PI turned over
[h] FO mis-grip
[i] FO drop during conveyance
[j] PI turned over
[k] Mis-grip
[l] PST mis-grip
[m] TR scrap
[n] PI turned over
[o] PI mis-grip
[p] PI turned over
[q] PI strap
[r] Strokes: 1,400
Processing time: 70 minutes
Activation loss time: 50 minutes
Preparation time: 5 minutes
Setting SPM: 18 - 22
Work SPM: 11.2
[s] Cumulative strokes

①Oil staining occurs once every 300 sheets due to PI turning over.

②High losses due to mis-gripping

③TR scrap clogging occurred on 850 sheets

Studying and introducing countermeasures



⑦ Line improvement item table (A0 size, A3 size)
[a] Process
[b] Description of problem
[c] Cause
[d] Countermeasure
[e] Schedule
[f] Person in charge
[g] Confirmation
[h] Distack[i] Drawing

⑥ Cumulative stroke graph and problem occurrence status
[a] Activation loss time (minutes)
[b] After countermeasures
[c] FO mis-grip
[d] FO drop during conveyance
[e] TR mis-grip
[f] FO drop during conveyance
[g] TR mis-grip
[h] TR mis-grip
[i] TR mis-grip
[j] TR mis-grip
[k] Strokes: 1,450
Processing time: 83 minutes
Activation loss time: 20 minutes
Preparation time: 5 minutes
Setting SPM: 23.0
Work SPM: 16.5

[l] Cumulative strokes
(1) Adjustment at start of production and after finger improvement
(2) Mis-gapping in TR process due to cutting burrs on lower mold

Conclusion

To summarize the information from the three examples:

1. Data is gathered through intensive observation for a short time.

2. Managers, staff, clerks, and workers participate.

3. Simple methods (cumulative graphs, histograms, etc.) are used.

4. Causes are investigates through closer examination of the work site.

5. Countermeasures can be instituted quickly to achieve improvements.

6. Data is gathered a second time through intensive observation for a short time.

7. The above steps are repeated several times.

8. Results appear naturally.

If this method, as described above, is implemented continuously for six months to a year, the workplace will begin to change. In other words, the workers will begin to cooperate in the improvements. The methods in which the staff do their work will also change. Different departments will cooperate with each other. QC activities will become more lively.

The workplace 5-S will proceed.

In addition, further improvements and rationalization will become possible. This method requires no special training. It can be implemented anywhere, anytime, by anyone, and applied to any process or problem.

Methods for TQC

Mr. Hideo YOSHIKAWA

(President, Intellect Co.,Ltd)

Union of Japanese Scientists and Engineers

UNION OF JAPANESE SCIENTISTS AND ENGINEERS
(NIPPON KAGAKU GIJUTSU RENMEI)
5-10-11, Sendagaya, Shibuya-ku, Tokyo 151, JAPAN

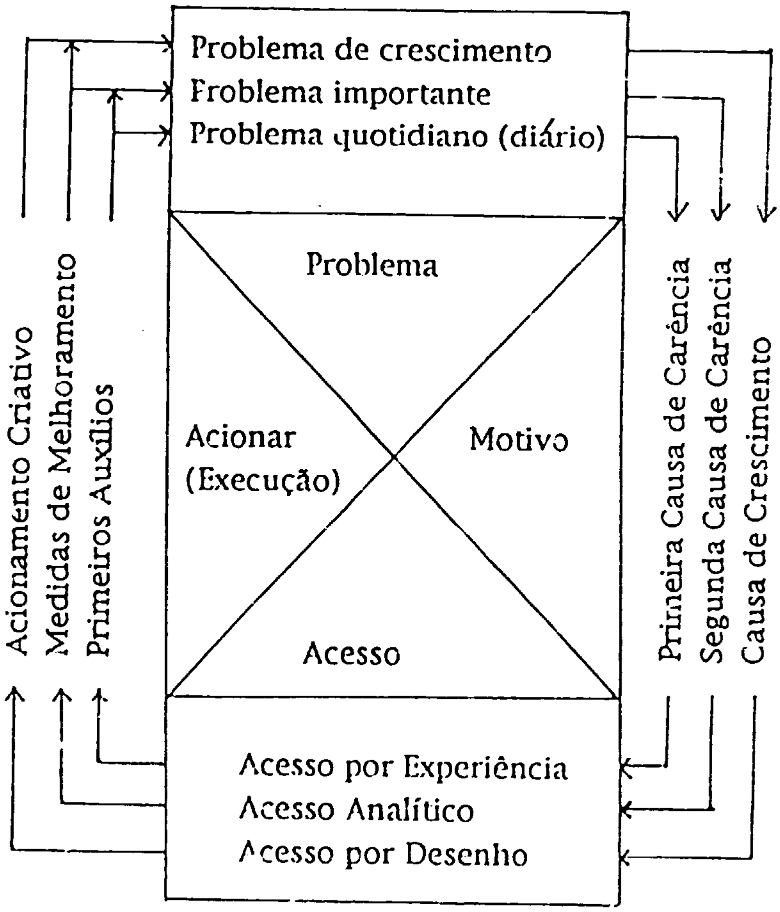
ATIVIDADES DE QC NOS SETORES INDIRETOS

§ 1 Problemas nos setores indiretos (venda, compra de materiais, assuntos gerais, contabilidade e distribuição)

1. Resposta com retardo às solicitações dos usuários.
2. Atraso na apresentação e falta de exatidão dos informes de vendas, pagamentos e do inventário.
3. Atraso das comunicações internas ou comunicações não transmitidas.
4. Entrega não efetuada ou devolução esquecida apesar de suficiente quantidade de estoque.
5. Abundância de materiais inúteis de informações no computador.
6. Perda de tempo dos encarregados na preparação dos materiais inúteis.
7. Problemas que surgem no começo de operação dos novos produtos.
8. Pessoal que não consegue desistir do método tradicional.
9. Câmbio de sistema cada vez que é designado um novo gerente.
10. Sempre repete o mesmo problema.
11. Intenção de aumentar novos usuários.
12. Intenção de desenvolver novos produtos.

§ 2 Ciclo de Problema - Motivo - Acesso - Acionar (Execução)

1. Esclarecer os problemas
2. Motivação
3. Indicar o acesso para solucionar os problemas
4. Acionar (Execução)



§ 3 Processo de seleção do tema

Ordenar os pontos problemáticos
Utilização da tabela MI (Management Improvement Chart = Tabela de Melhoria Gerencial)

[O que?] (Definição do Sujeito)
- Qual é a causa que pretende resolver? (Quem?)

[Por que?] (Razão)
- Qual é a realidade que existe?
- Qual é o problema que existe?
- Porque existe o problema?

[O que é que se pretende fazer?] (Meta)
- Pretende-se elevar a precisão?
- Pretende-se aumentar a velocidade?
- Pretende-se aumentar a produção?
- Pretende-se reduzir a produção?

1. ★ Tabela de Seleção de Temas para Melhoria do Sistema de Operação Indireta
2. Tabela MI
3. Ítem de requisição da seção de venda
4.

Data de Elaboração :	Dia mês ano
Nome/Empresa :	Empresa Comercial A
Departamento/Seção :	Seção de Venda
Nome	

Lugar de requisição Ítem de requisição	Na Própia Seção Ítem de requisição (Em concreto)	À quem ?	Avaliação Importância	Emergência	Expansão	Total	Órdem	O que é que se deve de fazer para captar a situação atual?	Periodo
Pretende Elevar (a precisão)	• A precisão das explicações escritas na folha de redação do plano de visitas.	Propia seção	7	5	8	20	○		
	• A precisão do nivel de conhecimento dos novos empregados sobre os produtos.	Empregados novos	7	8	4	19	△		
	• A precisão do sistema de anotações do plano de visita na forma mais comprensivel.	Propia seção e outros	8	5	5	18	△		
	• A precisão de descrição do conteúdo, em caso de reclamação no contrato.	Usuários	9	9	8	26	◎	Frequência de reclamações, revisão dos detalhes, impedir a reocorrência	
	• Do conteúdo de comunicação à filial A, referente a comunicação OOOO.	Filial A	5	7	6	18	△		
	• Do folheto de explicação distribuidas às lojas de vendas de grande volume.	Lojas de vendas de grandes volumes	8	6	6	20	◎		
Pretende acelerar (velocidade)	• Do conserto do produto B.	Usuários	9	7	7	23	○		
	• Do envio das peças ao conserto.	Usuários	8	9	6	23	○		
	• O inicio de venda do produto C por causa do rumor de que a empresa C vai lançar o produto de concorrência.	Seção relacionadas e outros	10	10	10	30	◎	Revisão do período de venda do produto C, estudar o período de venda	
	• Para chegar nos lugares de visita antes das horas marcadas.	Usuários	7	6	7	20	△		
	• No preenchimento da ordem de pedido para encurtar o tempo de transmussão com sede de produção.	Central de Produção	9	5	5	19	△		
Pretende Aumentar	• A visita na cidade D.	Cliente / cidade D	4	5	3	12			
	• Os vendedores na alta temporada.	Propia seção	5	3	3	11			
	• O nome do produtos entre os usuários.	Usuários	6	5	7	18	△		
	• O cubrimento das áreas do trabalho do pessoal femenino para fortalecer a empresa.	Pessoal femenino	5	5	4	14			
	• O catálogo de cada produto, porque só ha catálogo geral.	Promoção de vendas	7	6	4	17	△		
Pretende Reduzir	• Os informes diarios.	Propia seção	6	6	4	16	△		
	• A frequencia de reuniões de preparação.	Própia seção	8	5	7	20	△		
	• A comunicação com frequência.	Própia seção	7	7	5	19	△		
	• As reclamações até zero, do produto E vendidos aos usuários.	Usuários	9	8	8	25	◎	Estudar os detalhes de reclamações do produto E	
	• Os trabalhos internos	Propia seção	6	5	4	19			
	• Preparação de cotização e contratos dos produtos	Propia seção	7	7	7	21	○		
Outros									

§ 4 Motivação

1. **Forte exigência**

   Definição dos objetivos.

   Redução do inventário (estoque) até 50%.

   Reduzir para 1 dia, o tempo de resposta que leva 3 dias.

2. **Emergência de alto grau**

   Definição do grau de importância

3. **Manter a tensão**

   Deve-se requerer constantemente o necessário

4. **Processo de resolução esclarecido**

   Treinar o passo de resolução dos problemas através de dados.

5. **Repetição e persistência**

   Atuar repetidamente.

6. **Definição do prazo**

   Determinação do cronograma

7. **Satisfação pelo sucesso**

   Consegue-se a autoconfiança através do êxito.

§ 5 Processo para resolver os problemas

PROCESSO	FASSOS BÁSICOS	ÍTEM DE EXECUÇÃO
1	Seleção de temas	• Procurar o ponto do problema • Determinação de tema
2	Captação do estado atual e establecimento do objetivo	Captação do estado atual • Reunir os dados reais • Determinar o ponto de ataque (valor específico) Estabelecimento do objetivo • Determinação do objetivo (valor objetivo e prazo)
3	Planificação do acionamento	• Determinação do item de realização • Determinação do cronograma e distribuição dos encarregados
4	Análise de fator (processo fabril)	• Investigação do estado atual do valor característico • Identificação de fatores • Análise do fator (processo fabril) • Determinação de contramedidas
5	Estudo e execusão de contramedidas	Estudos de contramedidas • Exposição de idéias para contramedidas • Estudo concreto para contramedidas • Confirmação dos detalhes das medidas Execusão das contramedidas • Estudo da tabela de contramedidas • Execusão das contramedidas
6	Reconfirmação do efeito	• Avaliação do efeito das medidas tomadas • Comparação com o valor objetivo • Captação tangível e intangível do êxito
7	Adaptação de normalização e controle	Normalização • Estabelecimento e modificação de normas • Determinação do sistema de contrôle Adpatação de contrôle • Convicção total do pessoal vinculado • Formação dos encarregados • Reconfirmar o que tenha continuidade

§ 6 Sete Instrumetos do CQ

1. Estratificação (classificação de grupo)

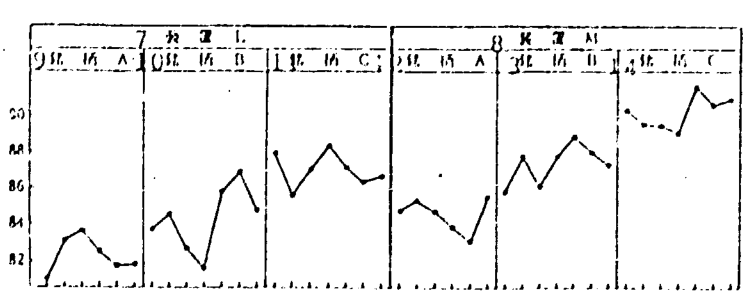
Estratificação, se refere ao sistema que pretende analisar a característica latente (essencial) que contêm o dado conforme à classificação dos dados do grupo com os pontos de semelhanca ou que tenha a mesma característica.

Surgiu alteração na proporção do rendimento num dos processos.

Os dados e os ítens redatados no reporte diário são separados em ítens de maquinária, marca do material e grupo de produção. Classificam esses dados para examinar as características e os pontos de semelhança dos 3 ítens mencionados.

Nº	Proporção /Rendimento	Máquinas	Marca do material	Grupo	Nº	Proporção /Rendimento	Máquinas	Marca do material	Grupo
1	81.1	L	A	1	21	85.8	L	B	3
2	85.9	M	B	2	22	87.8	M	B	1
3	83.7	L	B	3	23	86.9	L	B	2
4	90.4	M	C	1	24	89.1	M	C	3
5	88.0	L	C	2	25	87.1	L	C	2
6	89.6	M	C	3	26	88.4	L	C	3
7	87.8	M	B	2	27	87.2	L	C	1
8	84.5	L	B	3	28	86.4	L	C	2
9	84.8	M	A	1	29	83.1	M	A	3
10	83.1	L	A	2	30	85.5	M	A	1
11	83.6	L	A	3	31	81.7	L	A	3
12	89.5	M	C	1	32	81.8	L	A	1
13	85.6	L	C	3	33	88.9	M	B	2
14	86.1	M	B	1	34	91.6	M	C	3
15	85.3	M	A	2	35	84.7	L	B	1
16	82.6	L	B	3	36	90.7	M	C	2
17	84.7	M	A	1	37	86.6	L	C	1
18	81.5	L	B	2	38	91.0	M	C	2
19	82.5	L	A	1	39	88.0	M	B	3
20	83.9	M	A	2	40	87.3	M	B	1

Rendimento (%)



7, 8. Máquinas
9 - 14. Marca

2. Folha de Verificação

A folha de verificação é um sistema para examinar a característica latente dos dados. Esses dados são classificados na folha préviamente traçada e registrada com dados convertidos em símbolos e códigos.

Exemplo:

Últimamente, está havendo retardo de entrega dos produtos comprados.

A situação de recebimento com atraso dos produtos comprados durante o período de um mês foi retirada do computador para preparar uma lista. Porém, pela lista é difícil poder captar a situação geral. Para facilitar a análise utilizamos a lista de verificação para classificar os ítens principais.

1. O valor característico será o número de atrasos.
2. Coleta dos dados de um mês.

Fabricante	Peças	Unidade	Data de entrega prevista	Data da Entrega	Dias de atraso
A	Engrenage	100	10 de Julho	18 de Julho	-8
A	Eixo	200	12 de Julho	25 de Julho	-13
A	Barra	150	20 de Julho	27 de Julho	-35
•	•	•	•	•	•
•	•	•	•	•	•
•	•	•	•	•	•
B	Suportes	300	1º de Julho	03 de Julho	-2
B	Prensa A	200	""	04 de Julho	-3
B	Arruelas	150	""	09 de Julho	-8
•	•	•	•	•	•
•	•	•	•	•	•
•	•	•	•	•	•
C	Tubos	150	1º de Julho	04 de Julho	-3
C	Mangueira	200	05 de Julho	30 de Julho	-15

1. O ítem de classificação da folha de verificação representa em duo, o fabricante e os dias de atraso.

Fabricante	Dias de atrasos				Total
	Menos de 5 dias	6 a 10 dias	11 a 30 dias	Mais de 30 dias	
A		3	5	3	11
B	14	2			16
C	10	5	3		18
D	6		1		7
E			2	12	14
F	4			5	9
G	3	2	1		6
H	2				2
TOTAL	39	12	12	20	83

3. Diagrama Pareto

O sistema do diagrama Pareto, serve para avaliar a característica dos grandes estratos e comparar os estratos, colocando os dados estratificados em ordem decrescente.

1) Aplicação do diagrama Pareto para analisar o grau de atraso de cada produto. Nesse caso as medidas são tomadas por ordem de quantidade.

2) (1) O valor característico se refere ao caso do atraso de entrega e os ítens classificados são os diferentes produtos.

(2) Coleta de dados durante um mês, dos produtos que chegam com atraso.

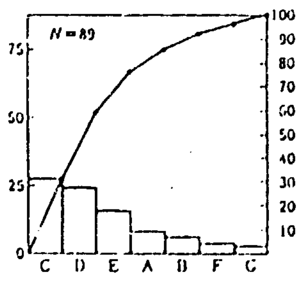
Produto	Data/entrega	Data/entrega real	Dias de atraso
A	5 de Julho	5 de Julho	0
A	5 de Julho	7 de Julho	- 2
A	25 de Julho	26 de Julho	- 1
•	•	•	•
•	•	•	•
•	•	•	•
G	20 de Julho	20 de Julho	0
G	29 de Julho	30 de Julho	- 1

Produto	Pedidos	Casos/atraso	Casos/acumulados	Acúmulo (%)
C	112	28	28	31.5
D	62	25	53	59.6
E	45	15	68	76.4
A	1223	8	76	85.4
B	669	6	82	92.1
F	140	4	86	96.6
G	164	3	89	100.0
Total	2415	89	89	100.0

(3) Preparação da tabela do número de casos de entrada com atraso, na ordem do número dos produtos.

Produto	Pedidos	Casos/atraso
A	1223	8
B	669	6
C	112	28
D	62	25
E	45	15
F	140	4
G	164	3
TOTAL	2415	89

Número /atraso



Acúmulo (%)

Produtos

4 Histograma

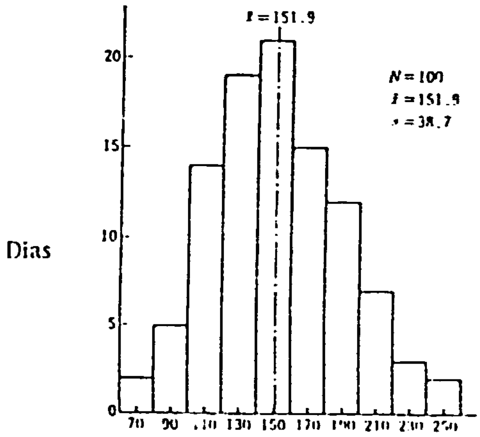
Histograma é um sistema que fiigura um grande volume de dados estratificados em forma de coluna para expor a imagem geral dos dados.

1) A venda oscila diáriamente. A imagem geral dessa oscilação pode ser captado através do histograma.

2) (10 mil Yens)

118	123	66	96	84	216	214	164	157	120
112	103	152	177	124	123	201	220	92	102
223	241	203	101	132	135	142	113	105	110
202	216	236	252	191	197	113	111	100	155
180	177	195	115	103	116	145	129	183	173
191	195	165	162	178	149	153	149	188	122
140	137	139	168	187	194	175	127	125	132
141	147	162	187	145	145	137	176	166	185
157	136	123	179	141	147	135	151	154	137
138	143	154	170	155	175	200	73	80	93

4) Calcular o valor médio e o desvio



3)

Nº de Categ.	Valor do limite entre seção	Valor médio	Revisão	Frequência
1	59.5~79.5	69.5	2	2
2	79.5~99.5	89.5	5	5
3	99.5~119.5	109.5	14	14
4	119.5~139.5	129.5	19	19
5	139.5~159.5	149.5	21	21
6	159.5~179.5	169.5	15	15
7	179.5~199.5	189.5	12	12
8	199.5~219.5	209.5	7	7
9	219.5~239.5	229.5	3	3
10	239.5~259.5	249.5	2	2
Total				100

5. Diagrama de Causa e Efeito (Característica)

É um diagrama para ordenar e analisar e estrutura qualitativa entre o valor característico e os fatores múltiplos, demonstrando os fatores relacionados a um valor característico na forma de espinha de peixe ou ramos de árvore.

1) Vamos intentar analizar os fatores causadores do não cumprimento de venda entre os vários fatores possíveis, tais como as atividades de visita, controle de venda e do mercado, assim como outras operações administrativas através da construção do diagrama de causa e efeito.

2)

(1) O valor característico é a [falta de cumprimento do objetivo de venda] .

(2) O pessoal da seção de venda enumera livremente as possíveis causas.

-1- Excesso de trabalho interior

-2- Não consegue efetuar as visitas planejadas

-3- Demora na preparação da cotização

-4- Por não conseguir cumprir o horário de visita

-5- Falta de coordenação entre as seções

-6- Dificuldade na obtenção de novos clientes

-7- Falta de utilização das concessionárias

-8- Ausência de unificação na forma dos informes

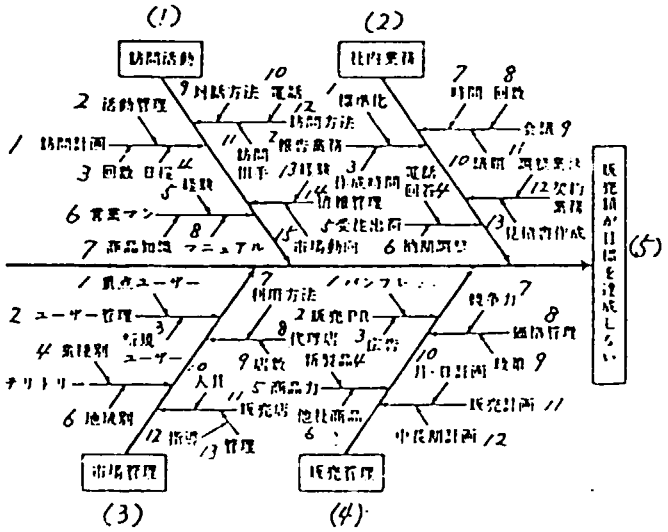
Diagrama de Causa e Efeito

特性要因図参照
(CONFERIR COM O NÚMERO DO DIAGRAMA)

(1) ATIVIDADES DE VISITA
(2) TRABALHOS INTERNOS
(3) CONTROLE DE MERCADO
(4) CONTROLE DE VENDA
(5) A CIFRA DE VENDA NÃO ATINGE O OBJETIVO

(1) ATIVIDADES DE VISITA

1 Plano de visita
2 Controle de atividade
3 Frequências
4 Cronograma
5 Experiência
6 Vendedores
7 Conhecimento dos produtos
8 Manual
9 Meio de diálogo
10 Telefone
11 Visitas aos usuários
12 Forma de visita
13 Experiência
14 Controle de informação
15 Tendência do Mercado



(2) TRABALHOS INTERIORES

1 Normalização
2 Trabalho de informação
3 Tempo de peraparação do informe
4 Resposta pelo telefone
5 Entrega por pedido
6 Ajuste do prazo de entrega
7 Tempo
8 Frequência
9 Reuniões
10 Temática
11 Trabalho de coordenação
12 Trabalho de contrato
13 Preparação de faturas

(3) CONTROLE DO MERCADO

1 Principais usuários
2 Controle dos usuários
3 Novos usuários
4 Por setor
5 Território
6 Por área
7 Método de utilização
8 Representantes
9 Número de lojas
10 Pessoal
11 Concessionários
12 Orientação
13 Controle

(4) ADMINISTRAÇÃO DE VENDA

1 Folhetos
2 Promoção de venda
3 Propaganda
4 Novos produtos
5 Força do produto
6 Produtos dos competidores
7 Competente
8 Controle do preço
9 Política
10 Programação diária e mensual
11 Programação de venda
12 Programação do médio e longo prazo

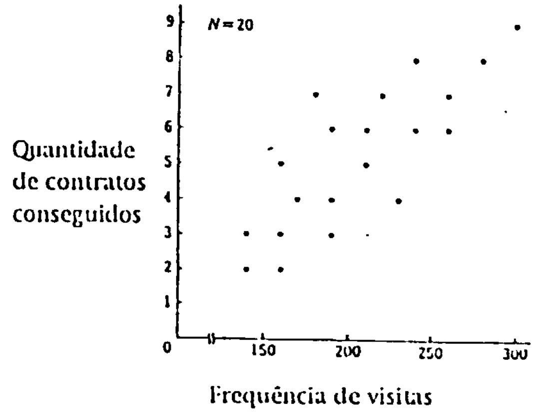
6 Diagrama de Distribuição

É um diagrama para analisar a correlação entre os dois diferentes tipos de dados em par e delinear no plano.

1) Dizem que a quantidade de contratos conseguidos pelos vendedores é relacionado com a frequência de visitas. Tentamos analisar neste diagrama, a correlação entre a frequência de visitas de cada vendedor e a quantidade de contratos conseguidos.

① Vendedor ② Frequência de visita ③ Quantidade de contratos

1	2	3	1	2	3
A	300	9	K	210	5
B	280	8	L	160	5
C	240	8	M	230	4
D	260	7	N	190	4
E	220	7	O	170	4
F	180	7	P	190	3
G	260	6	Q	160	3
H	240	6	R	140	3
I	210	6	S	160	2
J	190	6	T	140	2



7 Gráfico de Linha Quebrada

É um gráfico para analisar o câmbio cronológico, delineando os dados quantitativos reunidos cronológicamente e unir com linhas.

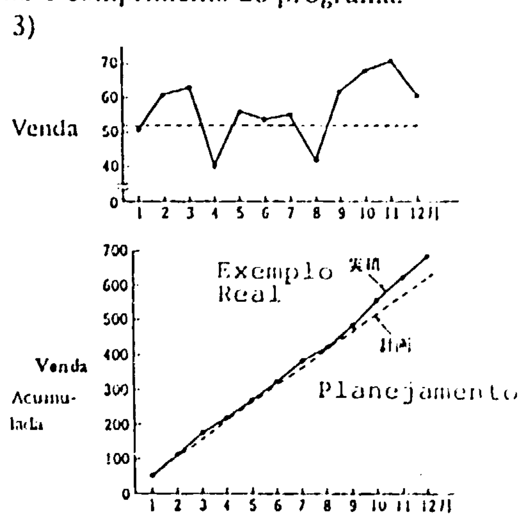
1) A situação de venda dos produtos são informados mensalmente.
Confeccionamos o gráfico de linha quebrada para conseguir cômodamente os resultados mensuais da evolução cronológica que é utilizado para controlar o cumprimento do programa.

2)

(1) O valor caraterístico de venda mensual é representado com um y.

(2) Coletânea de dados do programa anual de venda e os resultados reais da venda.

3)



	Mês	1	2	3	4	5	6	7	8	9	10	11	12
Programa	Acúmulo	52	52	52	52	52	52	52	52	52	52	52	52
	mensal	52	104	156	208	260	312	364	416	468	520	572	624
Resultados	Acúmulo	51	61	63	40	56	54	55	42	62	68	71	61
	mensal	51	112	175	215	271	325	380	422	484	552	623	684

§ 7 Exemplo Real para Execução

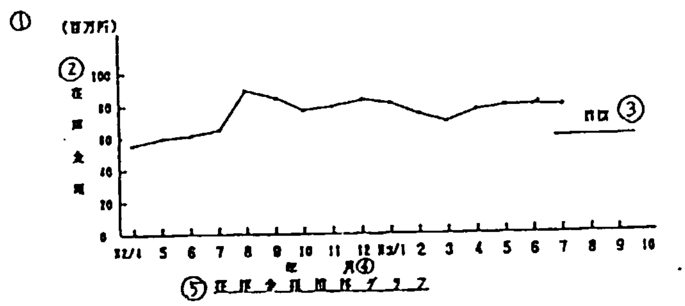
REDUÇÃO DE IMPORTE NO ESTOQUE DA EMPRESA "T"

NOME DA FIRMA: Material para Automóveis Co. Ltda.

Passo 1) Razão de escolher este tema

(1) A empresa "T" é uma firma 100% filial da empresa de Material para Automóveis Co. Ltda. que se dedica em controlar a compra de materiais recebendo os informes de balanço mensal, homem-horas, qualidade e estoques da matriz.

(2) O estoque da empresa "T" tende últimamente a aumentar e pretende reduzi-lo por afetar a situação financeira da empresa.



① Milhões de yens ② Importe do estoque ③ Meta ④ Ano Mês

⑤ Gráfico da avaliação do importe do estoque

Passo 2) Estabelecimento do Objetivo

- VALOR ATUAL 80.602 yens/mês (Média entre Abril e Junho de 1991)
- VALOR OBJETIVO 60.000 yens/mês (△ 25%)
- PRAZO DO CUMPRIMENTO 31 de Janeiro de 1992

Passo 3) O programa de execução e os nomes dos responsáveis estão abaixo relacionados.

Programa de execução

Programa	Meios	Responsável	Itinerário 9/91	10	11	12	01/92
(1) Captação do estado atual	① Coleta de dados	Yoshizawa, Noguchi					
	② Extração dos principais fatores por análise Pareto	Oomoto					
(2) Análise (Identificação de causas)	① Confecção do diagrama de causa e efeito	Todos					
	② Verificação das principais causas	Todos					
(3) Medidas e acionamento	① Estudo de medidas	Todos					
	② Execução de medidas	Takami, Yoshizawa					
(4) Reconfirmação do efeito	① Administração diária dos estoques	Yoshizawa					
	② Controle mensual do inventário	Takamizawa					
(5) Normalização e Prevenção de reocorrência		Takamizawa, Yoshizawa					
(6) Reflexão, problemas pendentes		Oomoto					
(7) Programas futuros		Oomoto					

Planejamento - - - →
Execução ——→

Passo 4) Análise do Estado Atual

1) Estratificação

Em primeiro lugar, estratifica-se o importe do estoque por produtos.

Captação do estado atual

(1) Estratificação do importe do estoque

Diagrama de Pareto do importe de estoque

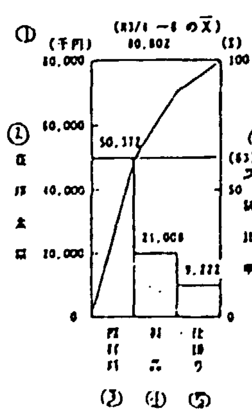
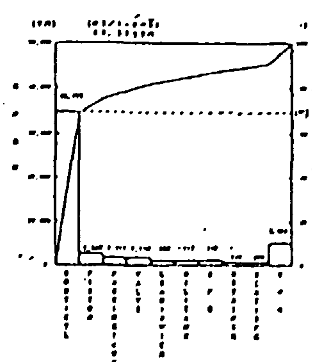


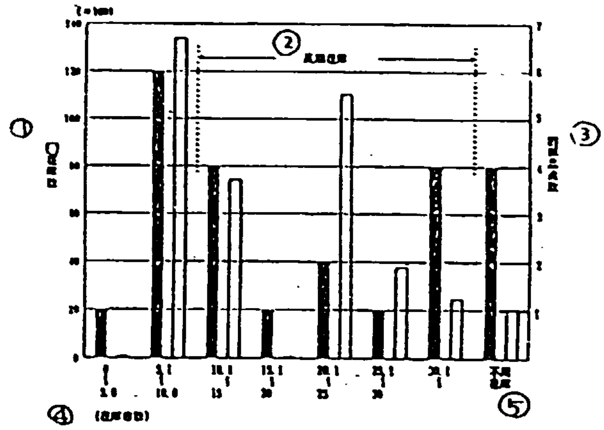
Diagrama de Pareto do importe da matéria prima



Comentário
① Excesso de matéria prima no estoque.
50.372.000 yens (60% do total)
② Excesso de BODY-CYL no estoque.
35.375.000 yens (70%)

Observação:
Investigar o estoque de BODY-CYL.

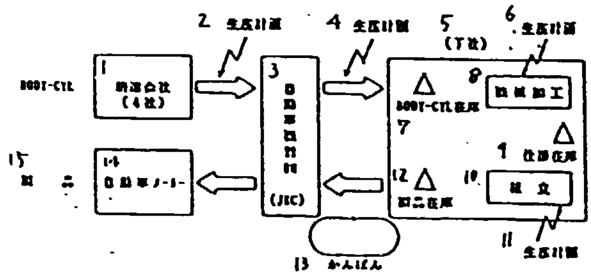
① Mil yens ② Importe do estoque ③ Materiais ④ Produtos
⑤ Produtos em processamento ⑥ Proporção cumulativa



① Quantidade do estoque ② Estoque de longo prazo ③ Quantidade de peças
④ Período de estoque ⑤ Estoque desnecessário

Passos 5) Análise dos fatores causadores

(1) Apresentação do fluxo das operações e processo fabril.
Fluxo do trabalho



-1- Fundidora
-2- Programa de produção
-3- Material para Automóvel Co. Ltda. (JKC)
-4- Programa de Produção
-5- Empresa "T"
-6- Programa de Produção
-7- Estoque de BODY-CYL
-8- Elaboração mecânica
-9- Estoque dos produtos em processamento
-10- Montagem
-11- Programa de produção
-12- Estoque dos produtos
-13- Kanban
-14- Fabricante de automóveis
-15- Produtos

① O abastecimento do BODY-CYL é conforme a indicação do programa de produção da JKC.

Usina de fundição → JKC → abastecimento à empresa "T".

② O "T" assume a programação de produtos, mecanização e montagem conforme o programa de ordem de pedido da JKC.

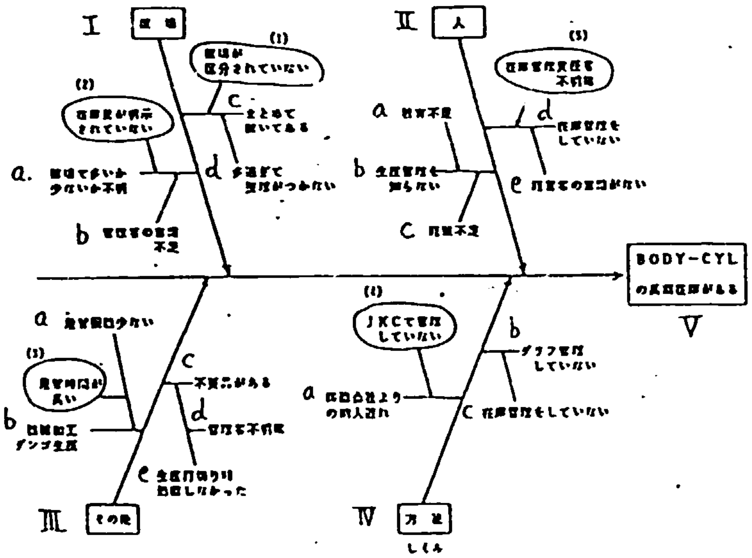
③ O "T" aplica o método Kanbam para abastecer ao JKC.

(2) Investigar a relação entre o valor característico e fatores no processamento fabril.

Diagrama de causa e efeito

Análises (identificação de causas)

(1) Diagrama de causa e efeito sobre a existência de estoque de longo prazo do BODY-CYL.



I. Depósito do estoque

(1) Não está classificado
(2) Não especifica a quantidade
a. No depósito não consegue esclarecer se ha muita ou pouca quantidade
b. Falta de obrigação do administrador
c. Estão colocados todos juntos
d. Não se consegue ordenar por excesso

II. Pessoal

(5) O administrador do estoque não está claramente determinado

a. Falta de capacitação
b. Desconhecimento do controle de produção
c. Falta de experiência
d. Não se executa o controle de estoque
e. Falta de conciência das diretrizes

III. Outros

(3) Emprega-se muito tempo para o câmbio de troquel
a. Pouca frequência de câmbio nos troquéis
b. Mecanização, produção desordenada
c. Existência de objetos inúteis
d. Indefinição do administrador
e. Não tomada de medidas adequadas na finalização da produção

IV. Medidas (mecanismo)

(4) Não se aplica o método de controle JKC

a. Atraso de entrega da fundidora
b. Não se utiliza o gráfico para o controle
c. Não se executa o controle de estoque

V. Existe estoque de longo período do BODY-CYL.

(3) Análises dos principais fatores causadores

Os fatores causadores podem ser classificados como sendo do sistema informativo (previsão, número de ordem de pedidos, número de recebimento e pagamento, quantidade do estoque, meio de administração do estoque de longo prazo) e do sistema físico (localização, forma de colocação). Se investiga a maneira de controle das causas mencionados.

Verificação dos principais fatores causadores

(2) Verificação dos principais fatores causdores

. Principais fatores	Resultados	Julgamento
(1) Não existe separação dentro do despósito	① Empilhamento, mistura na estocagem do BODY-CYL ② Desordem, sem os números de indentificação nos produto e nem classificação de destino de para a para a elaboração	○
(2) Não existe indicação de quantidade do estoque	① Não indica a quantidade regulamentada do estoque e nem a quantidade das caixas ② Não há definição de norma na quantidade do estoque	○

Passo 6) Confecção da Tabela de Planificação de Medidas

Tomando como base os resultados das análises do estado atual e dos fatores causantes, consegue-se encontrar a forma de medidas. Estas são indicadas no diagrama de árvore.

1) Medidas concentradas no sistema físico

Pensar as medidas e executar

Tabela de Medidas

Principais causas	Contramedidas	3~/4	JKC	5/4 JKC	6~7	3/9	10	11	12	1/1
Quando não existe separação no depósito	①	○		Yoshizawa	—					
	②	○		"	—					
Quando não existe indicação de quantidade do estoque	①	○		"	—					
	②	○		"	—					
	③		○	"	Takayama					
	④	○		"	—					

1- Principais causas

(1) Não existe separação no depósito

(2) Não existe indicação de quantidade do estoque

2- Contramedidas

(1) Quando não existe separação no depósito

① Revisão e melhoria do depósito de matéria prima através de separação e indicação

② Revisão e melhoria nos produtos em processamento

(2) Quando não existe indicação de quantidade do estoque

① Estabelecimento de norma no estoque

② Indicação de estoque máximo

③ Devolução dos produtos defeituosos (descontinuado)

④ Controlar para não estocar além do estándar (ordenar o estoque)

3- Distribuição de responsabilidade 4- Empresa T 5- Responsável 6- Itinerário
7- (Ano / Mês) 8- Yoshizawa 9- Takayama

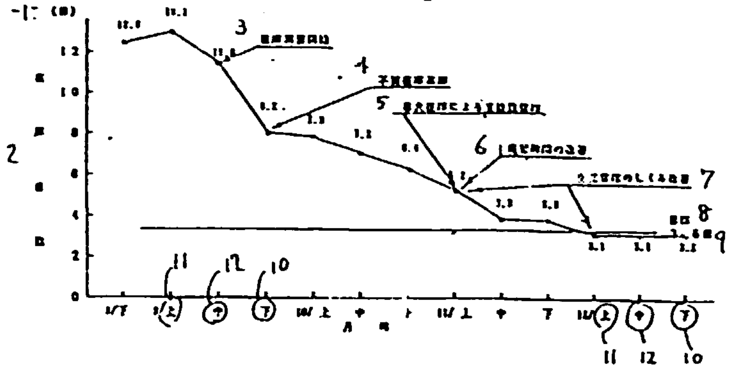
Passo 7) Resultado

1) Confecção do gráfico do importe do estoque

Confirmação do efeito

(1) Evolução dos dias de estoque da matéria prima MCY-BODY

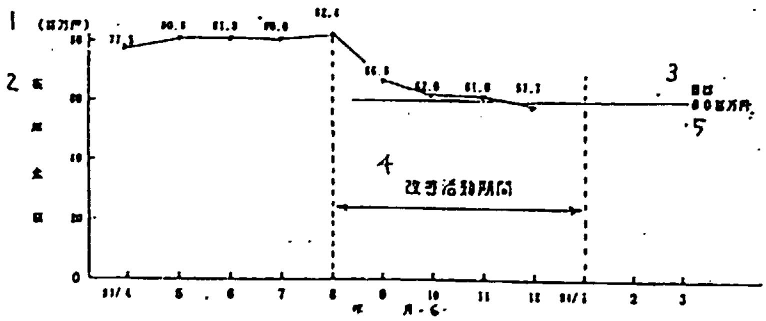
Gráfico de evolução dos dias de estoque MCY-BODY



-1- Dia -2- Tempo d : estoque -3- Início da elaboração do estoque
-4- Devolução do estoque defeituoso -5- Controle de qualidade de abastecimento
-6- Melhoria na organização de trabalho -7- Melhoria do mecanismo do controle de produção
-8- Objetivo (meta) -9- Dias -10- Inferior -11- Superior -12- Médio

(2) Evolução do importe (quantidade total) do estoque

Gráfico de evolução do importe (quantidade total) do estoque



-1- Milhões de yens -2- Importe do estoque -3- Objetivo (meta)
-4- Período de acionamento para melhoria -5- Milhões de yens -6- Ano Mês

Passo 8) Tabela de Normalização e Fixação

Normalização, Prevenção de Erros e Reocorrência

1 Ítens	Ítens decontrole	Normas de controle	Responsável	Período
(1)	Quantidade de Kanbam	± 1	Gerente Natori-JKC	1/2/91~
(2)	Tempo de estoque	Menos de 3.5 dias	Subdir. Yoshizawa -T	1/9/91~
	Importe do estoque	Inferior a 60 milhões/yens	Dir. fáb. Takamizawa -T	1/9/91~
(3)	Itinerário	Tempo de atraso - 5 dias	Dir. fáb. Takamizawa -T	1/11/91~
(4)	Itinerário	Tempo de atraso - 1 dia	Presid. Hirusaki-T	6/1/91~
(5)	Itinerário	Tempo de atraso - 5 dias	Dir. div. Oomoto-JKC	1/12/91~

1 Ítens (Tradução do quadro)

(1) Controlar a quantidade de Kanbam conforme o programa de produção
(2) Controle do estoque através do gráfico de controle de estoque
(3) Inventário mensual dos principais produtos
(4) Reunião sobre o estoque com o presidente (1 /semana)
(5) Reunião de intercâmbio de informações sobre controle de produção
(Empresa T ←→ JKC • 1/mês)

§ 8 Ponto cláve para obter êxito de melhoria

Os empresários que receberam as orientações durante o período de 10 anos, mais de 30 empresas conseguiram êxito na melhoria.

① As diretrizes devem ter como objeto e tomar atitudes objetivas e jutas.
② Controlar o egoísmo e ser resistente às críticas.
③ Identificação dos problemas.
④ Alta conciência de responsabilidade pública.
⑤ Prestar profunda atenção aos empregados.
⑥ Força de continuidade.
⑦ Não buscar efeito imediato.

Orientações

1) Orientar com base em boas relações humanas.
2) Orientar baseando-se em dados reais.
3) Orientar de uma maneira em que os empregados possam demonstrar suas capacidades

8 Diagrama de árvore

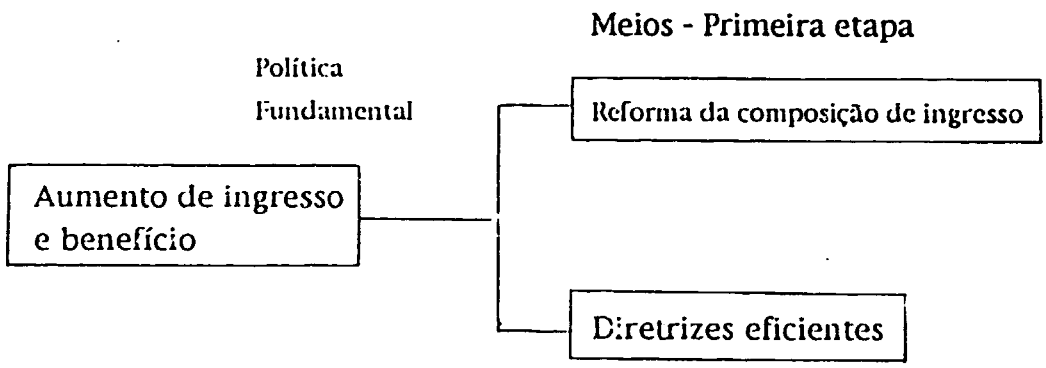
O diagrama de árvore é um método utilizado para comprender a estrutura qualitativa de um tema que consistem de vários fatores causadores entrelaçados complexadamente, através de ordenamento e análises estatísticas dos dados linguísticos que podem ser classificados em herarquicamente.

Passo 1 Objetivos

1. Um concessionário de equipamentos para transporte decidiu utilizar do diagrama de árvore para desenvolver a política fundamental de operação, com o objetivo de aumentar a venda e o ingresso das ações concretas.

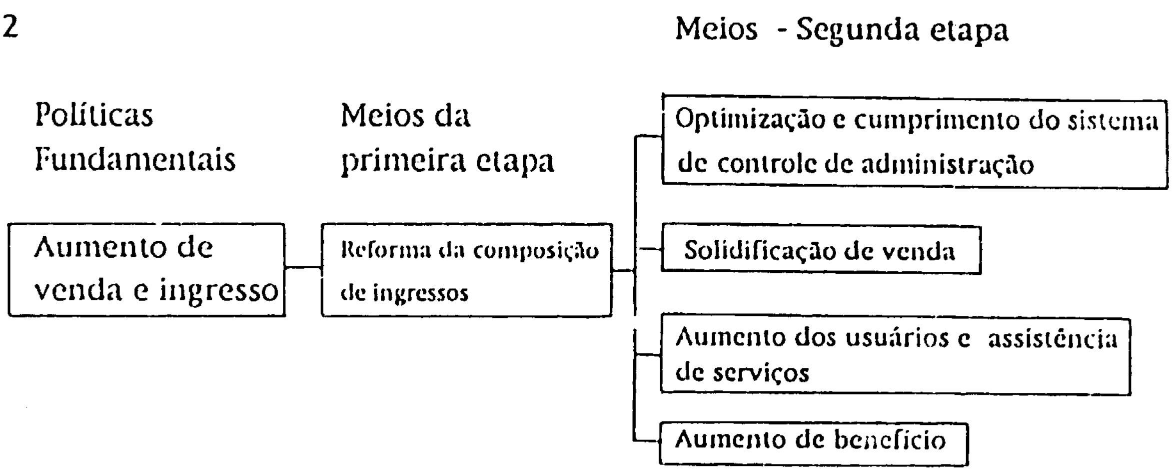
Passo 2 Confecção do diagrama

Processamento 1 Definição dos meios, na primeira etapa, para obtenção da meta.

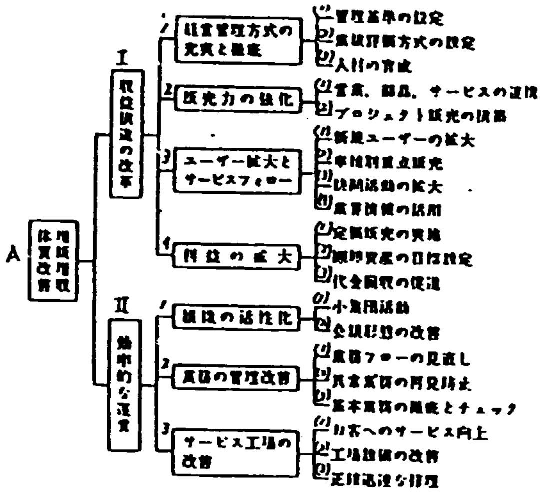


Processamento 2 Tendo como meta o processamento da primeria etapa, se estuda o processamento da segunda etapa.

2



Processamento 3



A - MELHORIA DA CONSTITUÇÃO - Aumento de venda e ingresso

I. Melhoria da estruturação do ingresso

1. Optimização e cuprimento no sistema de controle administrativo
   (1) Fixação das normas de administração
   (2) Fixação do sistema de avaliação do trabalho
   (3) Capacitação dos recursos humanos
2. Solidificação de venda
   (1) Associar os trabalhos entre as seções de vendas, peças e serviços.
   (2) Estruturação de venda de projetos.
3. Aumento dos usuários e assistência de serviços
   (1) Obtenção de novos usuários.
   (2) Concentração de venda por modelo.
   (3) Ampliação de actividades de venda.
   (4) Aproveitamento das informações do setor industrial.
4. Aumento de benefício
   (1) Execução de venda a preço fixo.
   (2) Definição de metas em relação aos bens do estoque.
   (3) Acelerar a cobrança do pagamento atrasado.

II. Administração eficiente

1. Dinamização da organização.
   (1) Atividades de pequenos grupos.
   (2) Melhoria em forma de reuniões.
2. Melhoria no controle de trabalho
   (1) Revisão de assistência do trabalho.
   (2) Prevenção de reocorrência de anormalidade no trabalho.
   (3) Verificação e cumprimento na operação básica.
3. Melhoria na oficina de assistência
   (1) Melhoria no atendimento dos usuários.
   (2) Melhoria na qualidade do equipamento da oficina.
   (3) Reparação rápida e correta.

9 Diagrama de Afinidade

O diagrama de Afinidade é um método para poder compreender a estrutura qualitativa de um tema confuso e desorndenado através do processamento de ordenação entre os dados linguísticos e a afinidade.

Passo 1) Objetivo

1 Existem diversas e confusas causas ao redor dos motivos de visitas de venda não cumprida, nesses casos se utiliza o diagrama de afinidade com a finalidade de ordenar os comentários e opiniões das pessoas vinculadas através de um franco intercâmbio de opiniões.

Passo 2) Confecção do diagrama

Processamento 1

Coletânea de dados linguísticos e descrição dos dados nas fichas.

Dados linguísticos a	Dados linguísticos b
Dados linguísticos c	Dados linguísticos d

2 I. As pessoas vinculadas se reúnem e descrevem livremente nas fichas as possíveis razões do motivo de visitas não cumpridas.

1

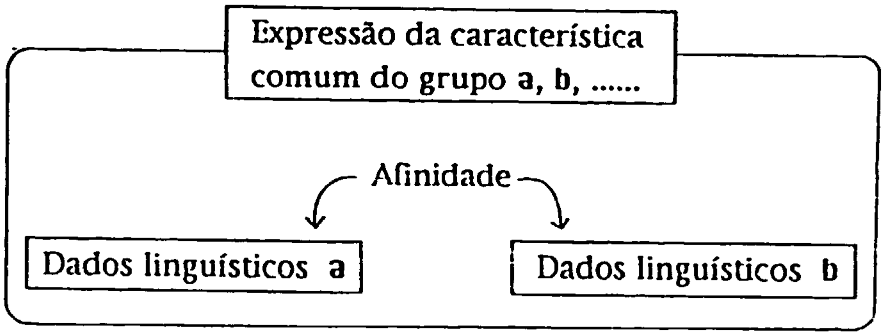
Falta de pessoal	Excesso de Informação do estoque
Excesso de trabalho interno	Numerosa preparação de contratos
Solicitação frequente de cotização	Má programação das visitas
Excesso de trabalho de despacho	Atraso de saída nas visistas da parte da manhã
Os clientes não recebem as visitas	Escassez de vendedores experientes
Reuniões internas frequentes	

2

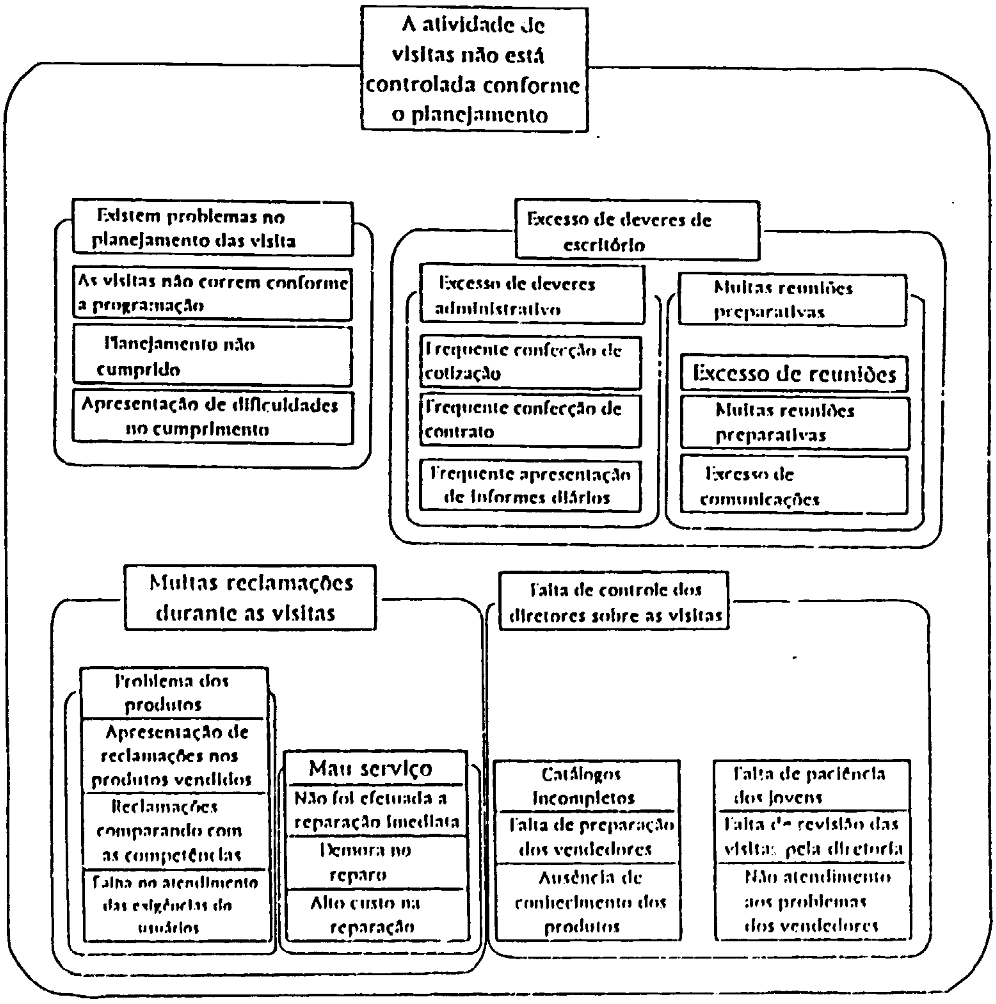
Excesso de trabalho de escritório
Solicitação frequente de cotização
Numerosa preparação de contratos
Excesso de relato de informe diário

Processamento 2

Reunir as fichas de dados e separar as que demonstram afinidades, para formar um grupo e preparar uma nova ficha descrevendo uma expressão que consiga distinguir a carecterística do grupo. Essa é chamada a Ficha de Afinidade.



Processo 3)Confecção do Diagrama de Afinidade



10 Diagrama de Matriz

O diagrama de Matriz é um método que tem como objeto, captar a estrutura dual (Plural) dos fenômenos ou assuntos, ordenando e analizando a intensidade da correlação entre os fatores dos mesmos.

Passo 1) Objetivo

1) Na ocasião do despacho, se apresentaram problemas como encontro de produtos anormais, falta de produtos e insufiência na quantidade. Nesse caso, se utiliza a Matriz para analizar esta situação através das várias causas correlacionadas.

Passo 2) Confecção

Processamento 1 Definição dos valores característicos (detalhes dos fenômenos e assuntos)

Processamento 2 Coletânea de dados

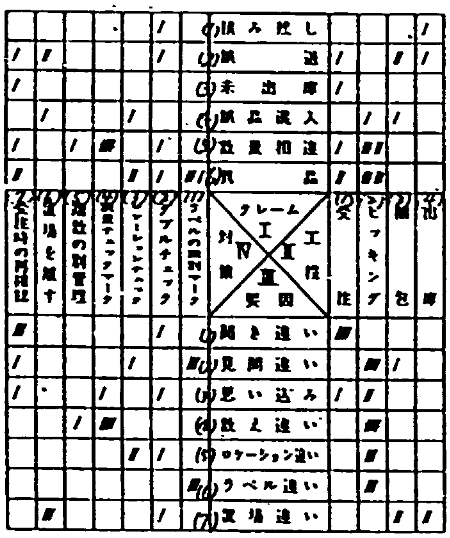
1)
(1) Os valores característicos se classificam nas seguintes formas: Reclamações, processo fabril, fatores causadores e contramedidas.
(2) Coleta de dados sobre os detalhes das reclamações, processo fabril, fatores causadores e contramedidas.

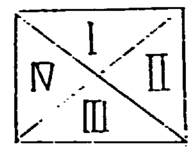
Data	Reclamações	Processo fabril	Fatores	Contramedidas
11/Out 12/Out	Produto anormal Erro de quantidade	Amostragem Recebimento de pedidos	Engano visual Engano auditivo	Controle de etiqueta Reconfirmação

Processamento 3 Definição dos fenômenos e assuntos (ponto de classificação)

(3) Os fenômenos e assuntos (ponto de classificação) são divididos em 4 ítens: detalhes das reclamações, processo fabril, fatores causadores e contramedidas.

Processamento 4) Confecção do Diagrama Matriz





I. Reclamações

(1) Carregamento esquecido
(2) Êrro de destino
(3) Despacho esquecido
(4) Mistura de produtos
(5) Êrro de quantidade
(6) Produtos anormais

II. Processo de produção

(1) Pedidos
(2) Retiragem
(3) Embalagem
(4) Despacho

III. Fatores causadores

(1) Engano auditivo
(2) Engano visual
(3) Erro no raciocínio
(4) Engano na contagem
(5) Lugar errado
(6) Engano na rotulação
(7) Depósito errado

IV. Contramedidas

(1) Marcação e classificação de etiquetas
(2) Dupla checagem
(3) Verificação de colocação
(4) Marcação de verificação de quantidade
(5) Controle na separação de frações
(6) Separação do local de colocação
(7) Reconfimação no momento do pedido

Passo 3) Análises

3) As principais causas dos produtos anormais são: êrro na quantidad e por engano visual no momento da operação de retirada e êrro na contagem, e se comprende que é necessário tomar as medidas controlando as etiquetas e reconfirmado as marcações. Através da utilização do diagrama Matriz consegue-se captar os assuntos complexos e os fenômenos.

11 Tabela de Qualidade

A Tabela de Qualidade, é o método que se utiliza para converter a qualidade exigida às características de qualidade, ordenando e analizando a intensidade de correlação entre os fatores de qualidade exigida e fatores das características de qualidade.

Passo 1 Objetivo

1) Confecção da tabela de qualidade para executar no aprimoramento da qualidade do tecido de decoração interior.

Passo 2 Confecção

Processamento 1 Coletânea de dados da qualidade exigida.

Observação: Os pontos cláves da coletânea dos dados.

- Conversão linguística dos dados baseado nas informações originais da qualidade exigida.
- Cambiar as expressões funcionais.
- Utilizar as expressões positivas.
- Enumeração das condições supostamente utilizáveis.

2)

(1) Coletar as reclamações e resultados de questionários referente às qualidades exigidas nos tecidos de decoração interior, desde o ponto de vista dos usuários.

Qualidade exigida

Característica primária	Característica secundária
Obtenção de comodidade na moradía	Bom desenho Tacto suáve
Ter a comodidade no tratamento	Não aderente à poeira Resistente a mancha Lavável
Ser agradável	Não descolore com o raio solar Não descolore ao lavar Não transmite energia elétrica
Ter a segurança e durabilidade	Anti-inflamável Forte e durável

Precessamento 2 Coletânea de dados dos fatores de qualidade

2) Coletar as características de qualidade (fatores de qualidade) disponível na seção de desenho e engenhería.

Característica de Qualidade	Característica do material	Característica do desenho
		Característica do desprendimento do tecido
		Característica da embalagem
		Material utilizado no tecido
	Durabilidade	Resistência contra o raio solar
		Resistência ao desgastamento
		Resistência contra o calor
		Resistência contra a corrente elétrica

Procesamento 3 Confecção da Tabela de Qualidade

Confeccionar a tabela dual consistente de qualidade exigida e fatores de qualidade.
Indicar com ◎ e ○ o grau de correlação dos ítens das filas e linhas, perspectivamente.

	I 要求品質		Ⅱ 品質特性	1 材料特性				2 耐久性			
	1 一次特性	2 二次特性		① デザイン性	② [illegible]	③ [illegible]	④ 使用材料	① [illegible]	② [illegible]	③ [illegible]	④ [illegible]
(1)	[illegible]	良いデザインである		○	○	○					
	[illegible]	手触りが良い		○	○	○	○				
(2)	扱いやすい	埃がつきにくい	c				○				
		汚れがつきにくい	d		○		○				
		洗いやすい	e			○	○				
(3)	不快感がない	日光で変色しない	f					○			
		洗いて変色しない	g								
		漏電しない	h				○				○
(4)	安全, 耐久性がある	燃えにくい	i				○			○	
		丈夫である	j				○		○		

I. Qualidade Exigida
1. Característica primária
(1) Comodidade na moradía
(2) Comodidade na conservação
(3) Ser agradável
(4) Ter segurança e durabilidade
2. Característica secundária
a. Ter bom desenho
b. Suáve
c. Não adere poeira
d. Não manchar
e. Fácil de lavar f. Não descora com o raio solar g. Não descora ao lavar
h. Não transmitir corrente elétrica i. Anti-inflamável j. Ser resistente

II. Característica de qualidade
1. Característica do material
① No Desenho ② No desprendimento do tecido ③ Na embalagem
④ No material utilizado no tecido
2. Durabiiidade (resistência)
① Contra raio solar ② Contra desgaste ③ Contra calor ④ Contra corrente elétrica

Passo 3 Análises e estudos

No análises do nível de importância dos ítens de qualidade, verificar se não houve falha ou omissão. Fazer também, o estudo comparativo com as outras empresas e o ponto-chave de comercialização.

2) Na exigência da qualidade existe grande importância no ítem da moradía e na característica de qualidade, existe grande importância na característica do material.

12 P D P C (Quadro de Programa de Decisão de Processo)

Este quadro é um método de descrever equemáticamente a justificativa e o planejamento adequado e prever no desenvolvimento do tema, o assunto e o fenômeno que se podem suceder.

Passo 1 Objetivo

1) Recebeu a encomenda do produto A com a condição de entrega no przo de 30 dias. Existem vários novos temas a serem resolvidos e corre-se o risco de não poder entregar. Para resolver a situação, surgiu a necessidade de confeccionar o quadro PDPC.

Processamento 1 Definição das características (tema)

2) 1 A característica (o tema) da nova encomenda do produto A, está no prazo de entrega. Determina-se a meta de entrega para o dia 1ª de abril.

Processamento 2 Coleta de dados

2 Reunir as pessoas envolvidas para discução dos pontos de execução (desenho, instalação, molde, materiais, preparação de homens/hora).

Processamento 3 Preparar folha de papel

1) Descrever o tema na parte superior do papel.

2) Descrever o valor meta com ◎ na parte inferior do papel.

3

1) Garantir a data de entrega da nova encomenda do produto A

2) Garantir a entrega no dia 1ª de Abril

Processamento 4 Descrever o acionamento primário dentro do ☐ e unir con linhas.

4

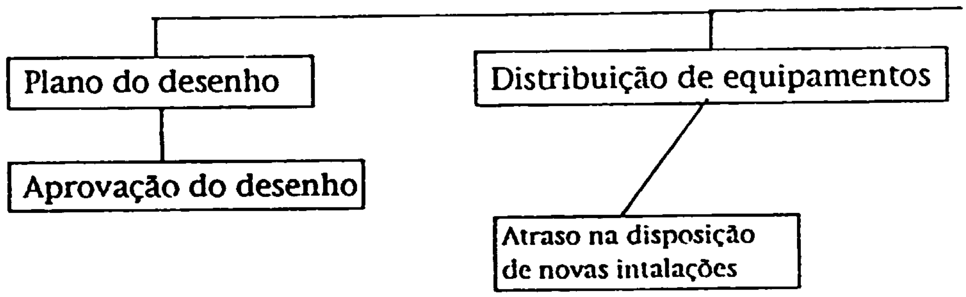
Assegurar a data de entrega

Plano do desenho

Distribuição de equipamentos

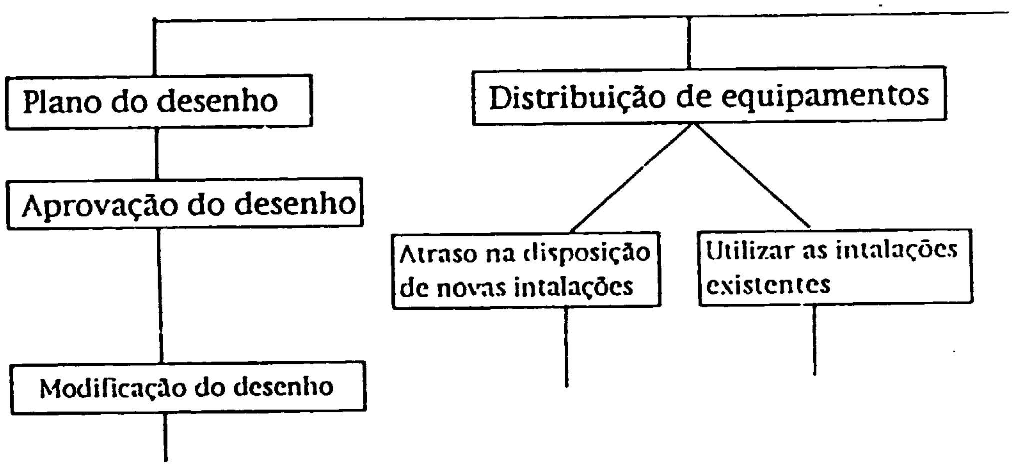
Processamento 5 Descrever o fenômeno de ocorrência previsto dentro do □ e unir os ítens de execução com linhas.

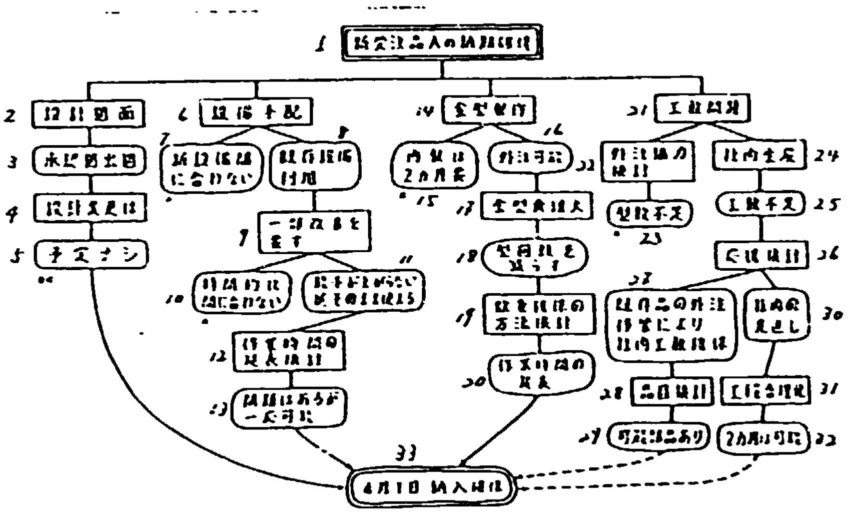
5



Processamento 6 Quando se toma a decisão de avançar os seguintes acionamentos, de acordo com os resultados das ações anteriores. Marca-se com um X no ítem de acionamento, quando se vê resultado negativo, e não se deve avançar.

6





(新受注品A納期確保表の訳 — Lista de radução da tabela de asseguramento de prazo)

1. Asseguramento do prazo de entrega da nova encomenda do produto A.
2. Plano do Desenho
3. Aprovação do Desenho
4. Modificação do Desenho
5. Sem programação
6. Distribuição das Instalações
7. Atraso na disposição de novas instalações
8. Disposição das instalações existentes
9. Necessidade de modificação parcial das instalações
10. Não há tempo
11. Cai o rendimento, mas pode-se utilizar
12. Estudar sobre o aumento de horas de operação
13. É possível apesar dos problemas existentes
14. Fabricação de troquéis (molde)
15. É necessário 2 meses
16. Possibilidade de encomendar os troquéis às empresas de fora
17. Aumento de custo dos troquéis
18. Redução da frequência de câmbio dos troquéis
19. Estudar as medidas asseguradora da quantidade
20. Aumento das horas de trabalho
21. Problema de homens/horas
22. Estudar a possibilidade de solicitar colaboração às outras empresas
23. Falta de troquéis
24. Produção dentro da própia empresa
25. Falta de homens/horas
26. Pedir o pessoal emprestado
27. Assegurar os homens/horas da própia empresa comprando os produtos existente das outras empresas
28. Estudar as gamas de produto
29. Existência das peças possíveis
30. Revisão da própria empresa
31. Racionalização do processo de produção
32. Possibilidade de entrega em dois meses
33. Asseguramento de entrega no dia 1º de Abril

Passo 3 Análises e estudos

Reafirmar se não houve omissão de pontos importantes no quadro confeccionado.

3) Definição de método, uma vez verificado que não há omissão e falha nos pontos importantes.

2-WEEK TRAINING COURSE
FOR FCAV, BRAZIL
UNIDO PROJECT
(TF/BRA/92/B10, DP/BRA/92/004)

ROLE OF TQC FACILITATORS

Ichiro MIYAUCHI

COUNSELOR, J U S E

UNION OF JAPANESE SCIENTISTS AND ENGINEERS

UNION OF JAPANESE SCIENTISTS AND ENGINEERS
(NIPPON KAGAKU GIJUTSU RENMEI)
5–10–11, Sendagaya, Shibuya–ku, Tokyo 151, JAPAN

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1. Preface

(A) Prior to implementing TQC into each enterprises, it is very important for top management to identify their specific necessity of TQC implementation schemes by their own clear-cut words for every employees easy understanding as shown in Fig. 1. According to our experiences, most commonality for TQC implementation triggers in Japanese industries are how to strengthen their Co's constitution for survival under upheaval environments exposed by economical, political, international and technological changes or innovations through break-through, under top management commitment for TQC implementation, as shown in Fig. 2 and Fig. 3.

The "Strengthening of Co's Constitution" means whenever, whatever, and wherever any unexpected nor undesirable changes takes place. The Co. can respond and survive such critical or risky circumstances to by TQC approaches.

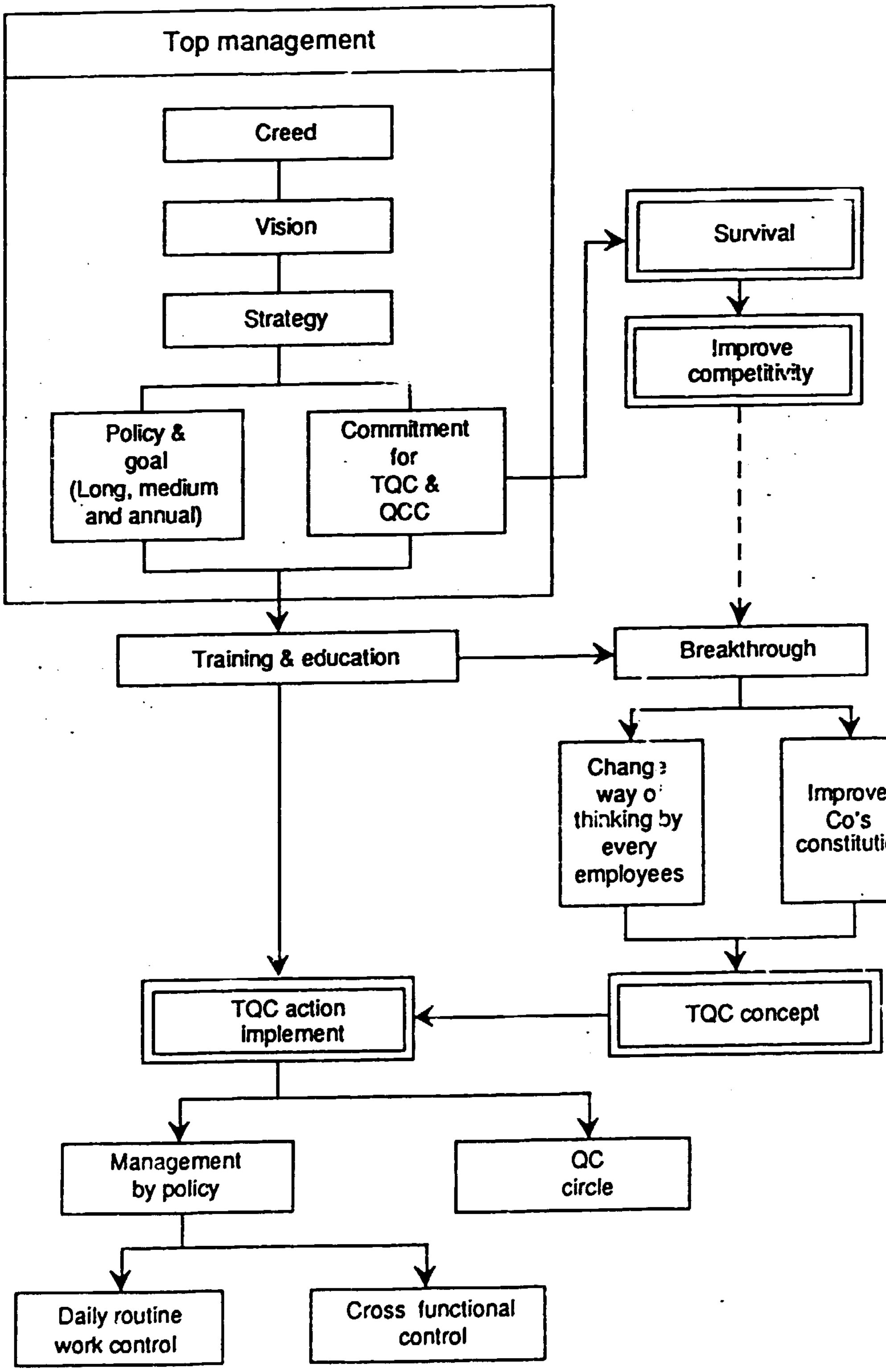


Fig.1 Top Management Commitment

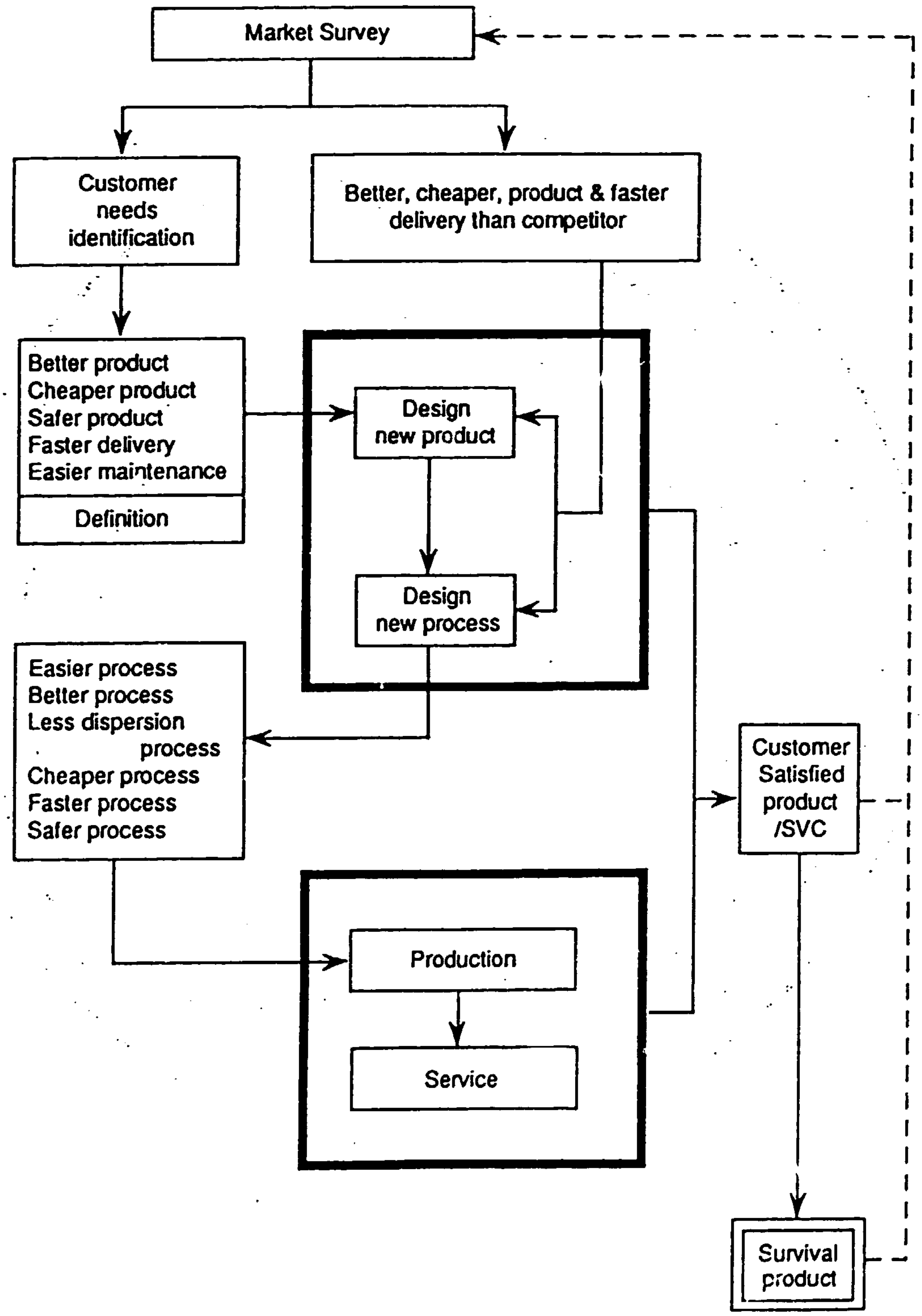


Fig. 2 Survival & Competitivity

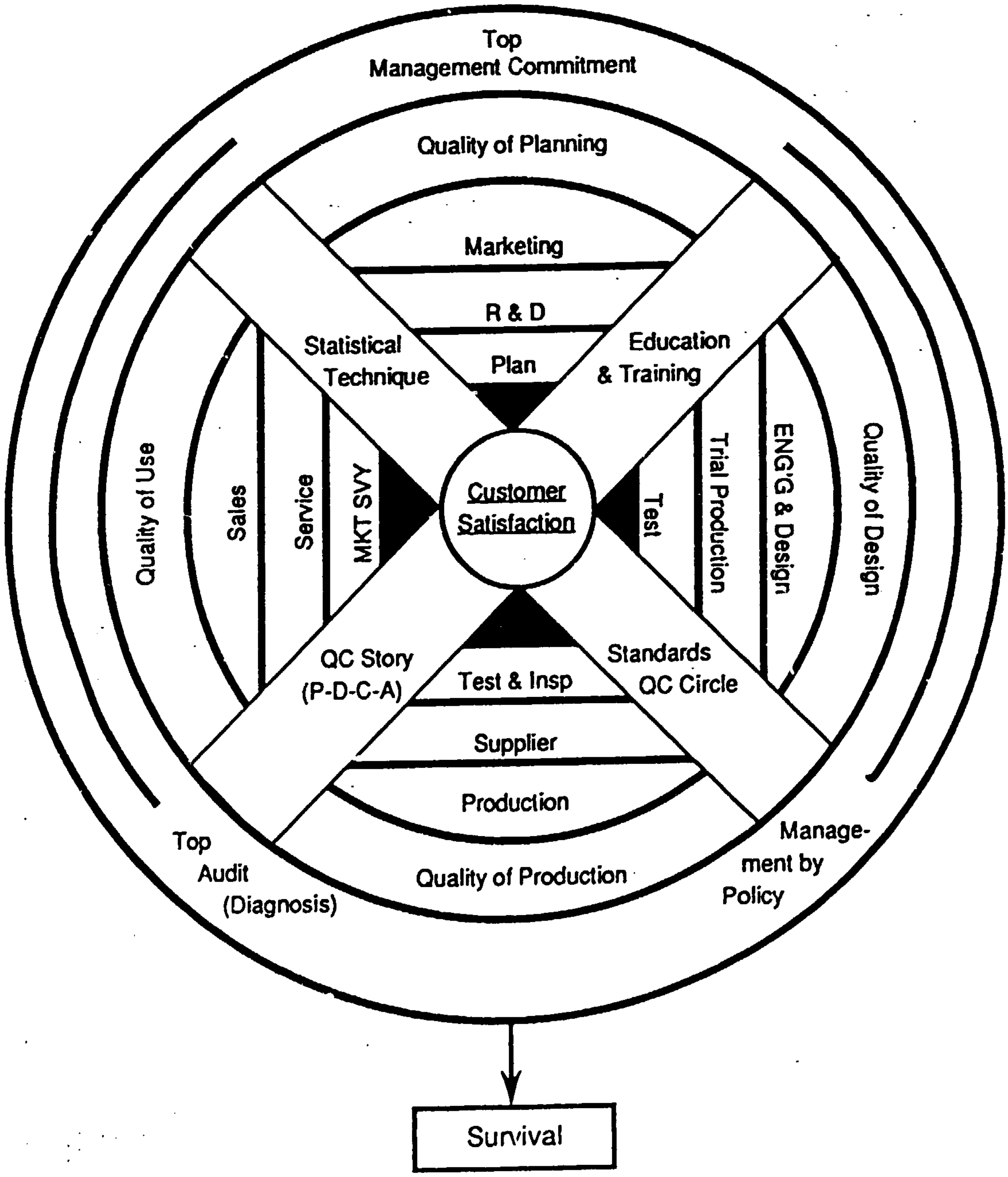
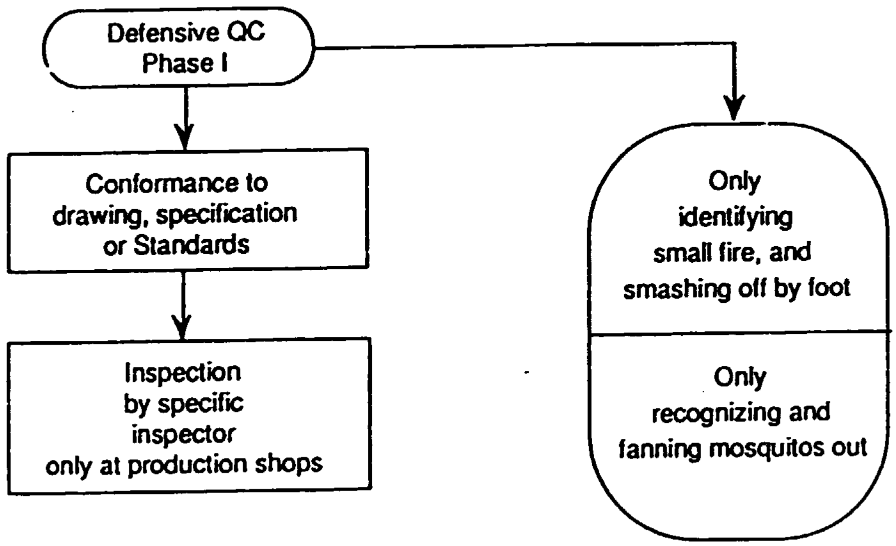


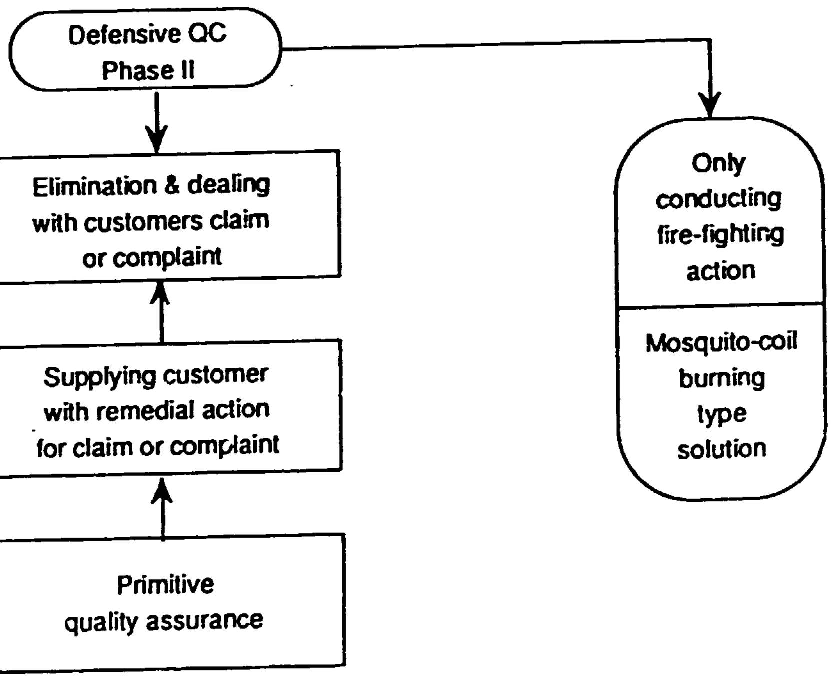
Fig. 3 Total Quality Control (TQC) Implementation Flow

(B) While implementing TQC, our experiences have revealed so many kinds of steps to be passed through until gaining full survival programs.

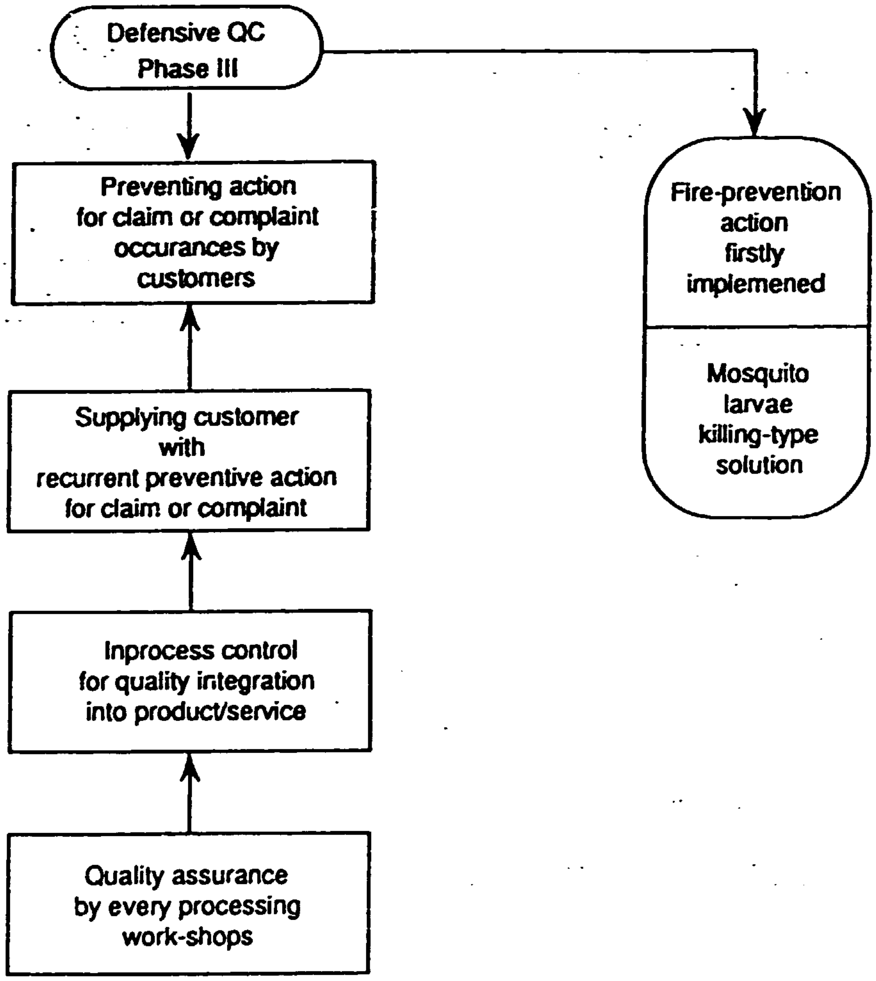
(1) Defensive Quality Control, Phase I
The defensive quality control is previously called as "Product-Out" quality control which could be illustrated in the followings.



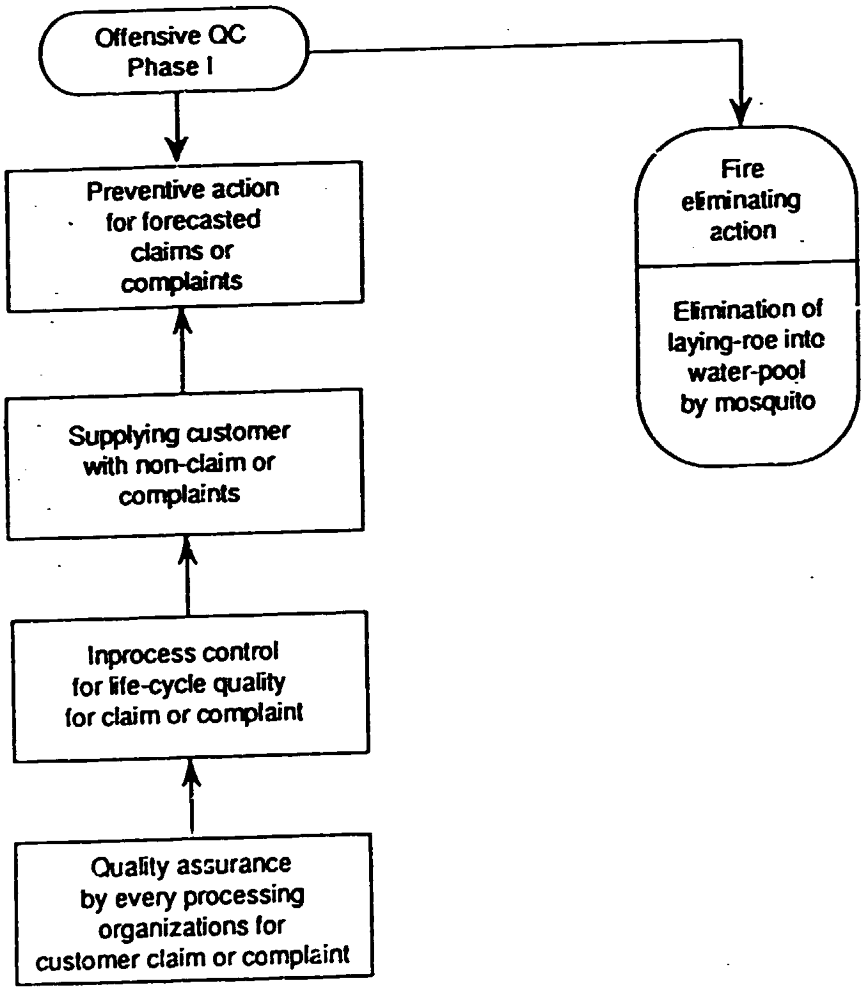
(2) Defensive Quality Control, Phase-II
(Mainly, claim or complaints handling)
In this phase there is slight awareness of customer satisfaction/needs by only dealing with customers "Claim" or "Complaints".



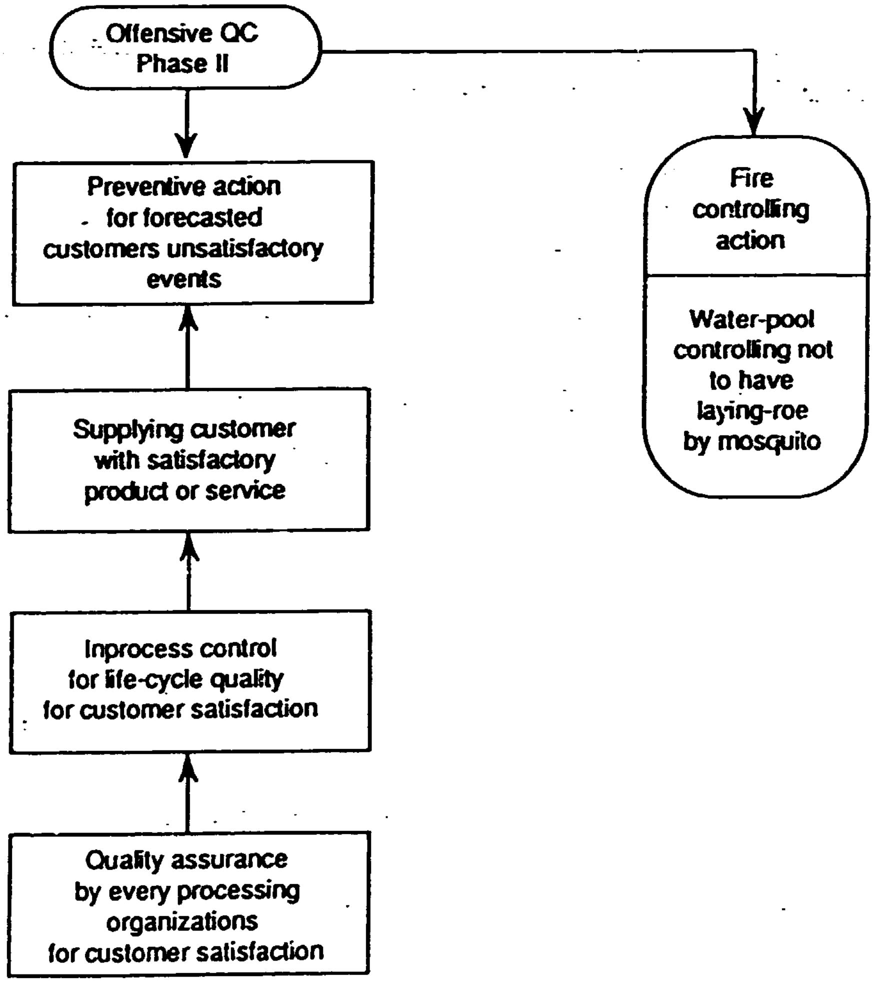
(3) Defensive Quality Control, Phase-III
(Prevention of claim or complaint)
This phase is based on quality control concept, which is prevention philosophy for customer claim or complaint



(4) Offensive Quality Control, Phase-I
(Prediction and elimination of claim or complaints predicted)



(5) Offensive Quality Control, Phase-II
(Prediction and elimination of customers unsatisfactory events predicted)



2. TQC Conceptual Operation (Management)

2.1 General Expression of TQC concept

TQC conceptual operation (Management) are generally explainable by following stated expression:

- Don't get mad.
- Don't shout.
- Don't exit.
- Speak with data, consider with data, and take action with data.
- QC means nothing but dispersion control.
- Customer is not God, but a king or a queen.
- Don't fight with customer who is a king or a queen.
- Listen first, instruct later.
- Not appreciate happy-ending report or story.
- Control not by result, but by inprocess.
- Any action and report must be followed by QC story.
- If only inprocess is fully controlled, no need for any final inspection (Inspector).
- QC is not conforming to spec nor drawing, but to customer demands (needs).
- Don't make any same mistakes.

2.2 TQC Concept

First of all, TQC concepts are necessary to explain how they are constituted, as follows:

(1) Market-in (Customer oriented) concept
(2) "Quality First" concept
(3) "Vital Few Oriented Action" concept
(4) "Fact & Data Appreciation" concept
(5) "Process Control for Quality Assurance" concept
(6) "Dispersion Control in Process" concept
(7) "Next Down-Stream Shops are Customer" concept
(8) "Upper Stream Control" concept
(9) "Recurrent Preventive Action" concept
(10) "Respect Employee as Human Being" concept
(11) "Top Management Commitment" requirement

3. Detail Explanation of TQC Concepts

3.1 "Market-In" (Customer Oriented Action)

"Market-In" concept can be interpreted as follows:

(A) "Empathy" oriented behavior (You put yourself in his place, concept)

(B) Provide only acceptable & affordable product/service to customers

(C) Not supply "Product-Out" product/service

(D) Customer is not God, but a king or a queen.

3.2 "Quality First" (Customer full satisfaction)

This can be interpreted.

(A) Product/service quality have the highest priority in business management, which have much higher predominancy than sales turn-over increase, cost reduction, productivity improvement, market share progress, etc.

(B) Quality is comprised of not only just product/service quality, but of price, cost, time, quantity, safety, employees morale and every employees outputs in daily routine works, etc.

C) Customer voice must be appreciated as "God-Whisper".

3.3 "Vital-Few" Oriented Action - Brain, Time & Fond Constraint

This can be interpreted, as:

(A) Human being has only one brain, that no brain spaces be available for more than one concentration at a time, unless a genius.

(B) A person who is grumbling about work piled up is mostly spending not "Vital Few", but only "Trivial Many" dealing with.

(C) Identify and isolate "What items/issues deserve enough attention to deal at this time, under brain-work, time-and fund-constraints".

3.4 Fact & Data Appreciation - Scientific Approach

This can be interpreted, as,

(A) Rush to the place where it happened.
Verify the fact (Failure, defect, claim or complaint) on the spot.
Take action of every possible counter-measures at that time.

(B) Speak
Consider — with Data
Take action

(C) Collect specifically data which explains the facts as shown in Fig. 4.

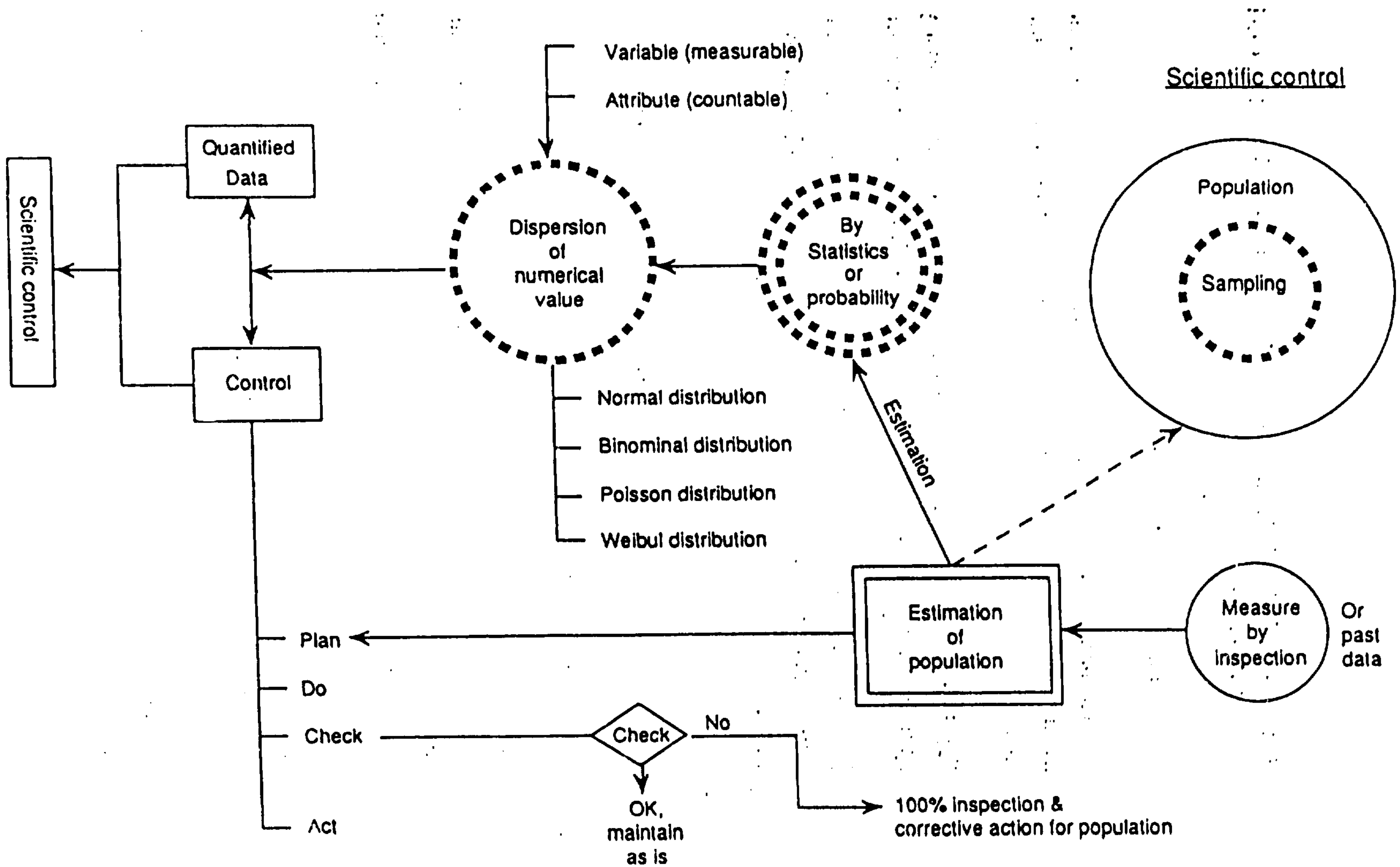


Fig. 4 Data Source

3.5 Process Control (Prevention plan & implementation)

Process control means that if only every employees at every stage in every organization are doing right at the first time and every time to conform with specific SOP, drawing, specification or processing standards by self-check or self-controlling methodology.

(A) Under product life-cycle concept, every stages are to be called inprocesses as for customer, shown in Fig. 5, which are required to assure their accomplishment for customer both in-house and real out-side customers.

(B) At the same time, each stages have their own sub-processes for achieving of their responsibilities, as shown in the followings,

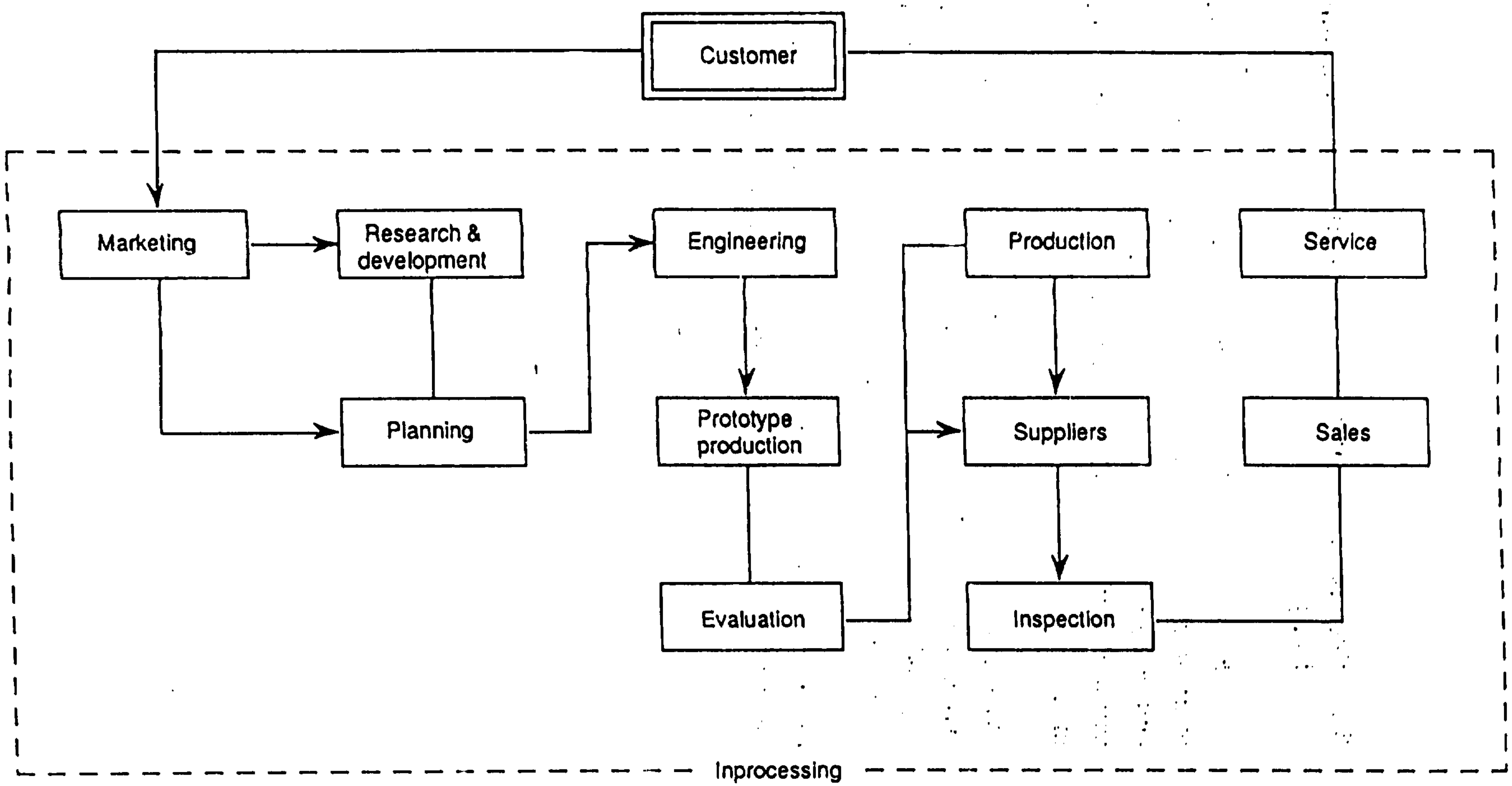
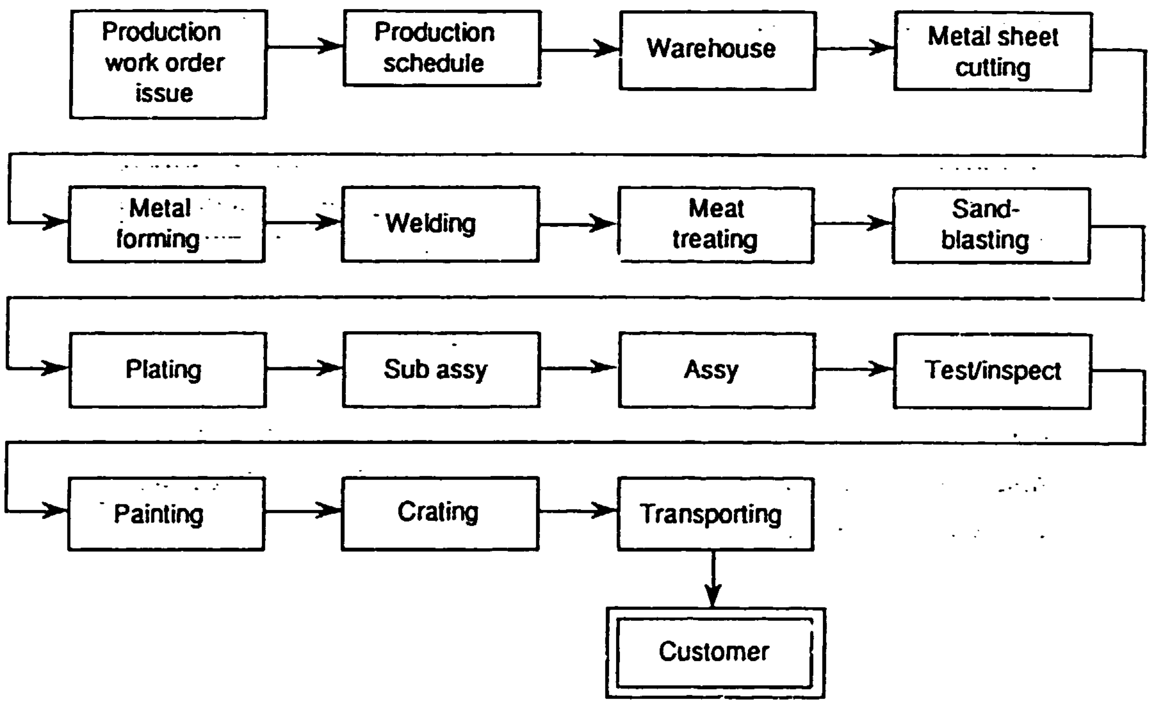


Fig. 5 Product Life-Cycle

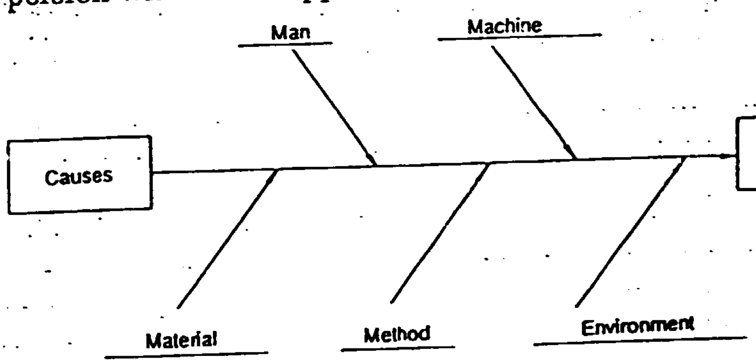
in production stage, various processings are also



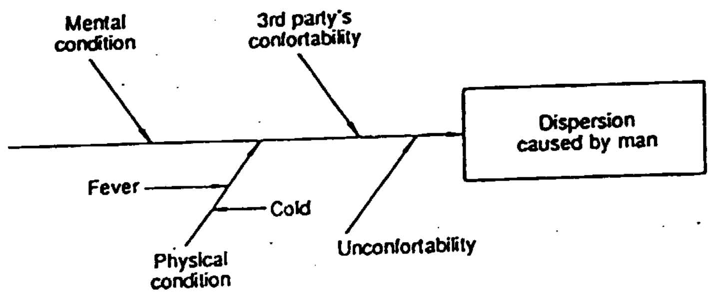
located as inprocesses by different organizations.

3.6 Dispersion Control

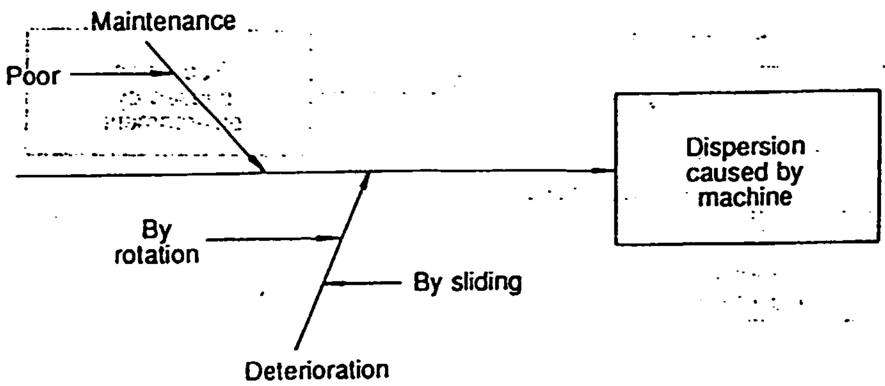
Today's quality control is nothing but how to control dispersion which are happened at various

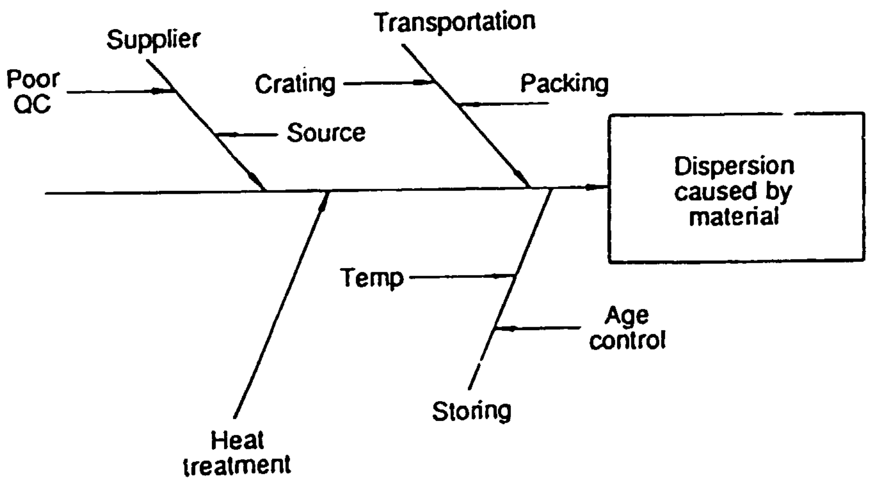


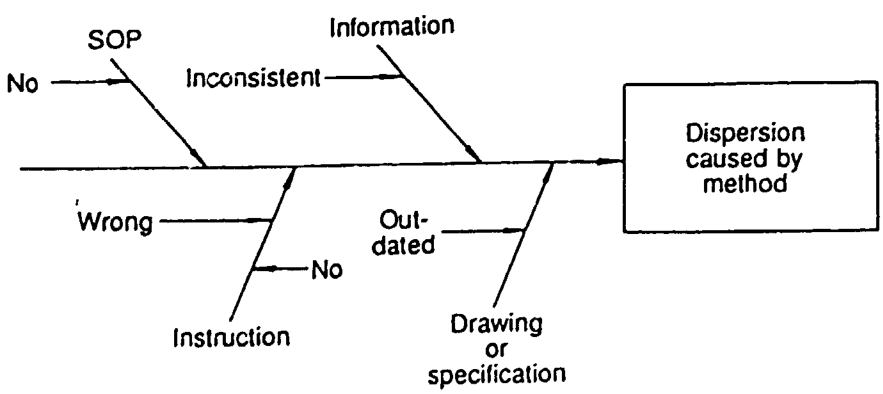
causes — such as man, machine, material, method, and environment (4M1E factors) as shown in the aboves. These 4M1E factors are independently.

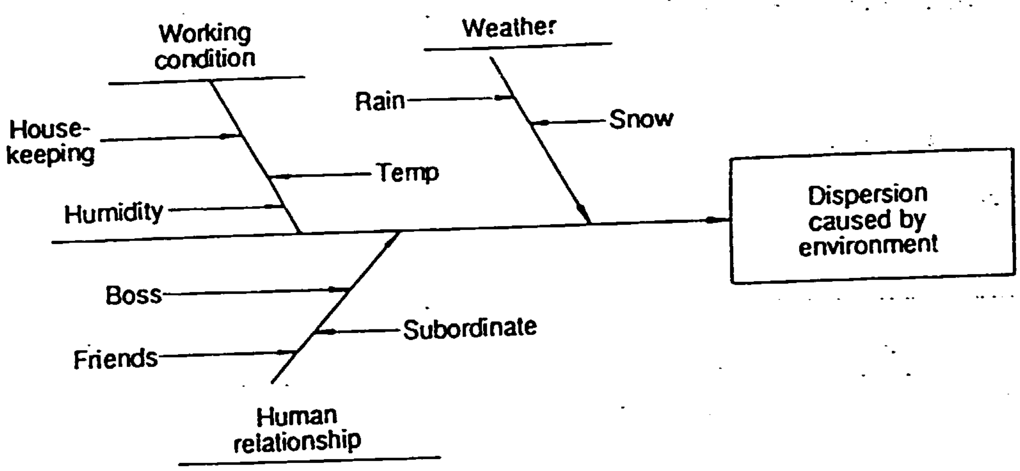


or interactionally dispersed by as shown in the following:








Working condition
Weather
House-keeping
Rain
Snow
Temp
Humidity
Dispersion caused by environment
Boss
Subordinate
Friends
Human relationship

3.7 Next Down-Stream Shops are Customer

Customer is a King or a queen, as mentioned before however, except for marketing or sales personnel, most of employees have no chance to physically contact with and deal with customer that this concept is rather impossible to understand and to follow by the inprocessing employees. To solve these difficulty, the next down-stream shops are treated as customers, that is, for in-house customers their outputs must be accepted by the next down-stream shop operators.

Accordingly, through inprocess control concept, upper stream-shop operators are required to assure the quality of their work for the downstream customer.

3.8 Upper Stream Control

As shown in product life cycle diagram in para 5, marketing organization is located to the nearest to customers that unless they are recognizing their role and responsibility which are to have customers need/requirement for every down stream shops, such as planning, engineering, quality control or production, the whole down stream shops could not identify how to plan, design, produce or quality assure for customers. The marketing is situated at an entrance gate for quality. Accordingly the upper stream shops' responsibility such as not only marketing, but planning & design are fully understood and implemented into their organizations. To implement them, it is necessary to consider and prepare for,

(A) Establish new product development and quality assurance system flow charts to integratedly control from upper stream to lower one.

B) Establish quality deployment system and identify "Real Quality" for customer satisfaction.

(C) Evaluate results at every predetermined stations to identify if goals for every stations are achieved or not. If found non-achievement, don't neglect it until correction be made.

(D) Predict any difficulties or problems at planning, R & D, design and prototype production stages, to prevent from any troubles at down-streams.

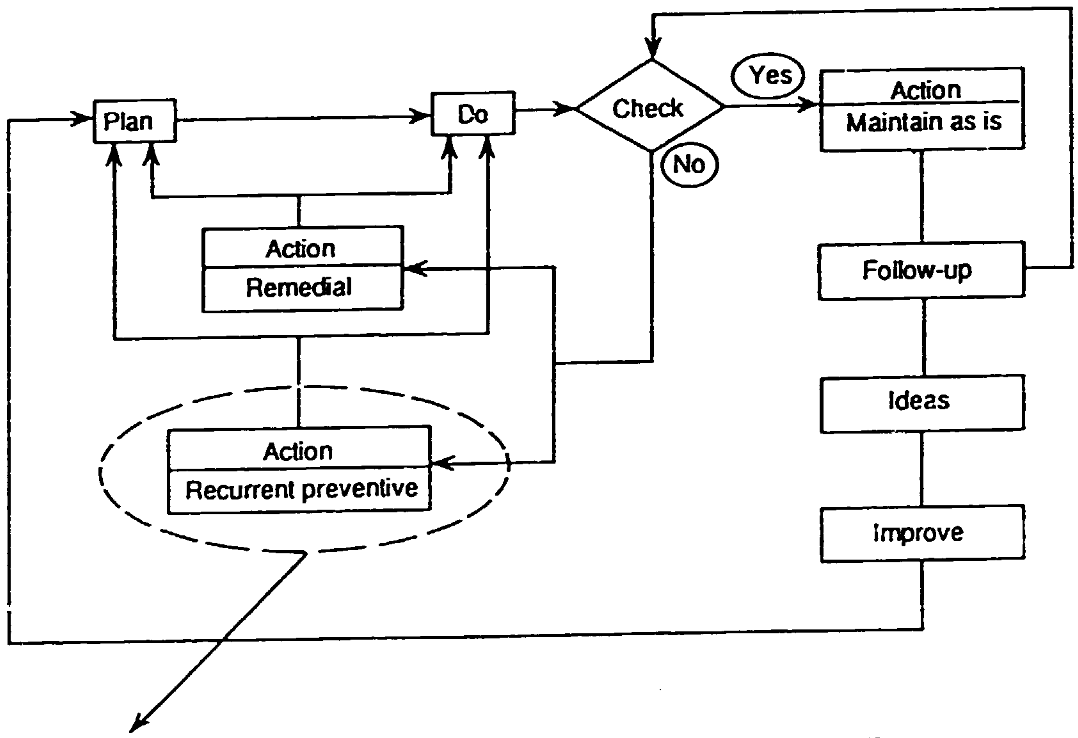
(E) Improve processing flow by improving of each processing of development phase.

(F) Identify root-cause for difficulties or problems by chasing-up to upper stream organizations.

(G) Prepare various SOP, flow chart, process standard, regulation or check sheet for prevention and assurance for customer satisfaction.

3.9 Recurrent Preventive Action (Repetitive failure is shame)

Under Plan-Do-Check-Act (QC Story) process, the following stated flow must be followed by every employees,



and when found something wrong at Check stage, "Recurrent Preventive Action" are a must for Plan or Do stage for not happening again by the same cause, under "Repetitive Failure/ Defect is Shame" concept.

3.10 Respect Employees as Human Being (Employees are precious assets.)

It is a time for top management to reconsider the famous behavior scientists concept as such McGregor's Y-Assumption, Maslow's Hiarachy, or Hertzburg Survey, which are summarized as follows. To handle and treat employees for adult-human being.

A) Provide task variety to avoid boredom
B) Enlarge the job to meet skills and ability of worker
C) Provide feedback on performance
D) Provide job closure or job identification
E) Self-control of significant aspect of the work
F) Opportunity to learn new skills
G) Participation in problem solving, planning and controlling

3.11 Top Management Commitment (Employees full participation)

Top management is necessary to declare definitely why TQC is a must to implement while explaining of

A) Co's situation,
B) Co's vision and strategy with his creed
C) Competitors
D) Technological or technical innovation status

why QC circle is necessary under TQC concept.

To have every employees participation or involvement for survivability and prosperity to subjugate present upheaval ages.

4. TQC Implementation Action

TQC is now ready to implement by the following stated actions:

(1) Education and training	—	Understanding
(2) Establishment of Standards	—	Consistent quality
(3) Implementation of "Plan-Do-Check-Act" concept	—	Control cycle – Improvement and maintaining cyclic action
(4) Implementation of "Management by Policy" methodology	—	Commitment & Deployment
(5) Utilization of statistical method	—	Systematic & scientific way
(6) Avoid/diagnosis by top management	—	Leadership of top management
(7) Q C. circle activity	—	Involvement

5. "QC Story" Processing

It is necessary for TQC implementing Co's employees to explain their actions by sound processing sequences, as stated below, which are called "QC Story" based on Plan-Do-Check-Act cycle.

(1) Establishment of project
(2) Identification of present status
(3) Analysis of data & fact obtained
(4) Isolation of root-cause(s)
(5) Establishment of counter-measure(s)
(6) Execution of counter-measure and evaluation of result(s) obtained
(7) If effective, standardize it as permanent fix. If not, repeat Para 2 to Para 6.
(8) Identification of residual problem and future program

These sequential processings are called as "Sound", as shown in table 1, because,

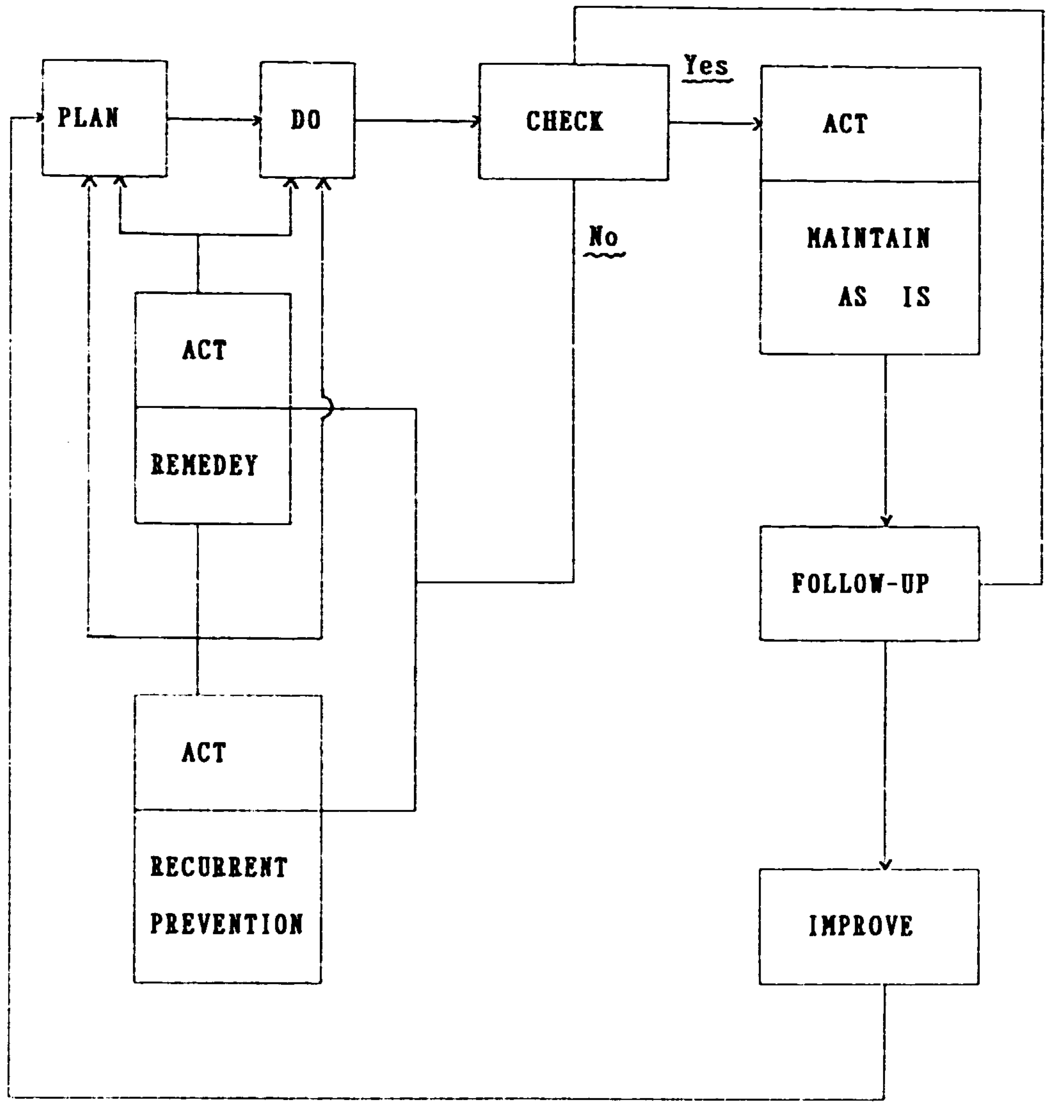
1) Clearly to state why this project is necessary to tackle at this moment, which means priority
2) To analyze situation & environment for project accomplishment based on data/fact
3) To clarify relationship between cause(s) and result(fact), and for project accomplishment, to isolate probable contributions
4) To establish counter-measure(s) for probable contribution by thorough studying of various alternatives planned for counter measures

The detail processing procedures will be explained in the succeeding sub-paragraphs, and typical reporting model is explained in Table 2.

Table 1 Non-QC Story Approach

Quack Doctor Approach		QC Story Approach
Patient complained "Head-ache" at dispensary	1	Found defects in product fabricated.
Without, any medical examination for why "Head-ache" is occured.	2	Without, any study or analysis for why defect is occured by foreman.
Prescribe medicine for "Cold".	3	Change operator.
Relieved of Head-ache	4	Disappeared of defect.
Doctor convinced himself "Head-ache caused by cold".	5	Foreman convinced himself "Defect caused by bad material".
By prescription, doctor examined patient	6	By result (defect), foreman looked for cause.
Temporarily, head-ache looks "Healed" but may happened "Head-ache" again in future	7	Temporarily, defect looks corrected but may observed "Defect" again in future
Patient visited doctor again, but doctor change medicines without examination	8	Foreman is surprised, and change operator, or machine still w/o root cause isolation.
May be cured by this prescription, but he could not explain why gone that his medical skill would never be improved.	9	May be temporarily corrected, foreman could not identify why defect be gone that his problem solving capability would never be improved.

Table 2 QC Story Flow Chart

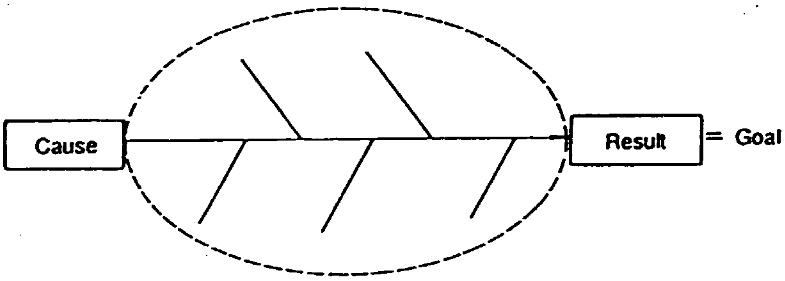


5.1 Establishment of Project

(A) Select quantifiable/measurable goal for project accomplishment

— Data retrieval time with 10'
— Repaint finish reduction less than 50%

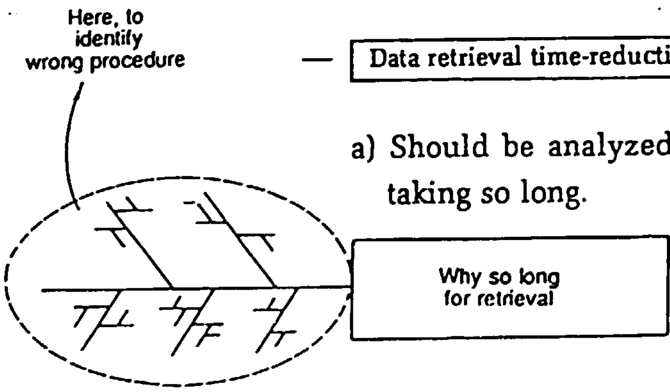
(B) Goal selected must be located on result (Why so bad, or why to happen approach), not in cause area.



(C) Counter-Measure ("How To" procedures) should not be selected as goals, but only result ("Why To" procedures)

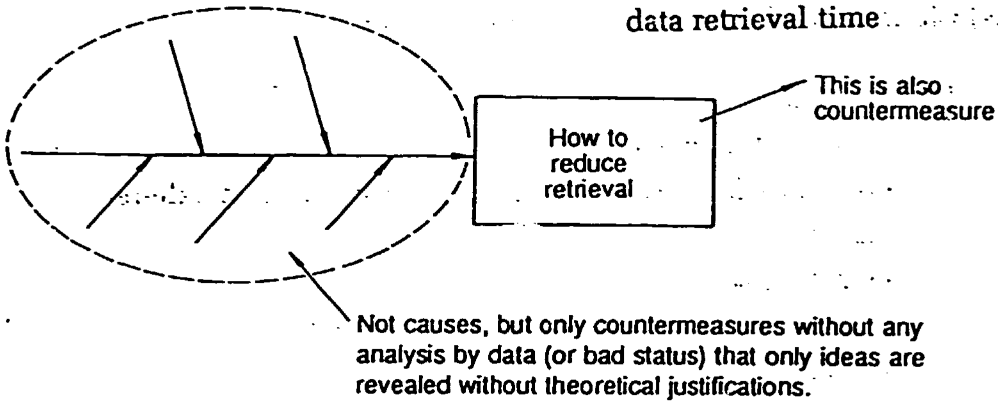
— Data retrieval time-reduction

a) Should be analyzed why taking so long.



But,

a)' If started, how to reduce data retrieval time



5.2 Justification of the Project Tackling

(A) Clarify why the project is necessary to tackle

(1) By data,

- is it controllable or uncontrollable?
- is it quality, cost, quantity, time, safety, or morale-related?
- which area?
- what kinds of problems — Sporadic / Correctable
- when was it observed?
- is it potential, hidden or exposed?
- is it tangible or intangible?

(2) By criteria

- is it normal or abnormal through control-chart limits?
- is it within or out of specification or drawing requirement?
- is it conforming or not to top management goals specified?

(B) Determine

(1) Date to be finished (— By the end of Jan. 1990)

(2) Goal to be accomplished (— 20% reduction of failure rate)

- Intangible effectiveness
- Tangible effectiveness

(— How much be anticipated to be saved.)

5.3 : Identification of Present Status

(A) Summarize any available data, or collect new data to identify degree of the present status (how good or how bad), by :

- Quantitative data

or

- Qualitative data

(Don't miss, customers information (data) are mostly belonged this category)

(B). Justify if data collected/summarized are reliable enough to use, by

- Validation of hardware — Product, equipment, machinery related with Project.
- Visitation of place or area related with Project
- Verification of phenomenon (How good or how bad status).

While assuring if same or similar kinds of data can be collected.

(C) Stratify any data, as shown in Fig. 3, by 5W1H approaches:

By when?	By What?
By where?	By why?
By who?	By How?

(D) Study the stratified data if any dispersion or variation be observed,

- By graphication as possible as can for easy observation as shown in Fig. 6, against
  - — Specification or drawing criteria
  - — Control limit
  - — Goals specified by top management or own's senior MGT

- If dispersion found,
  - — Try to find any other similar dispersion by comparing with another case-studying for confirmation of this kinds of dispersion.
  - — These case studyings are recommended to find at least 2 or more up to 5 cases.
  - — It is necessary to hasten for data collection until locating right case-studying
  - — If only one-case be available, be sure careful studying for right interpretation.

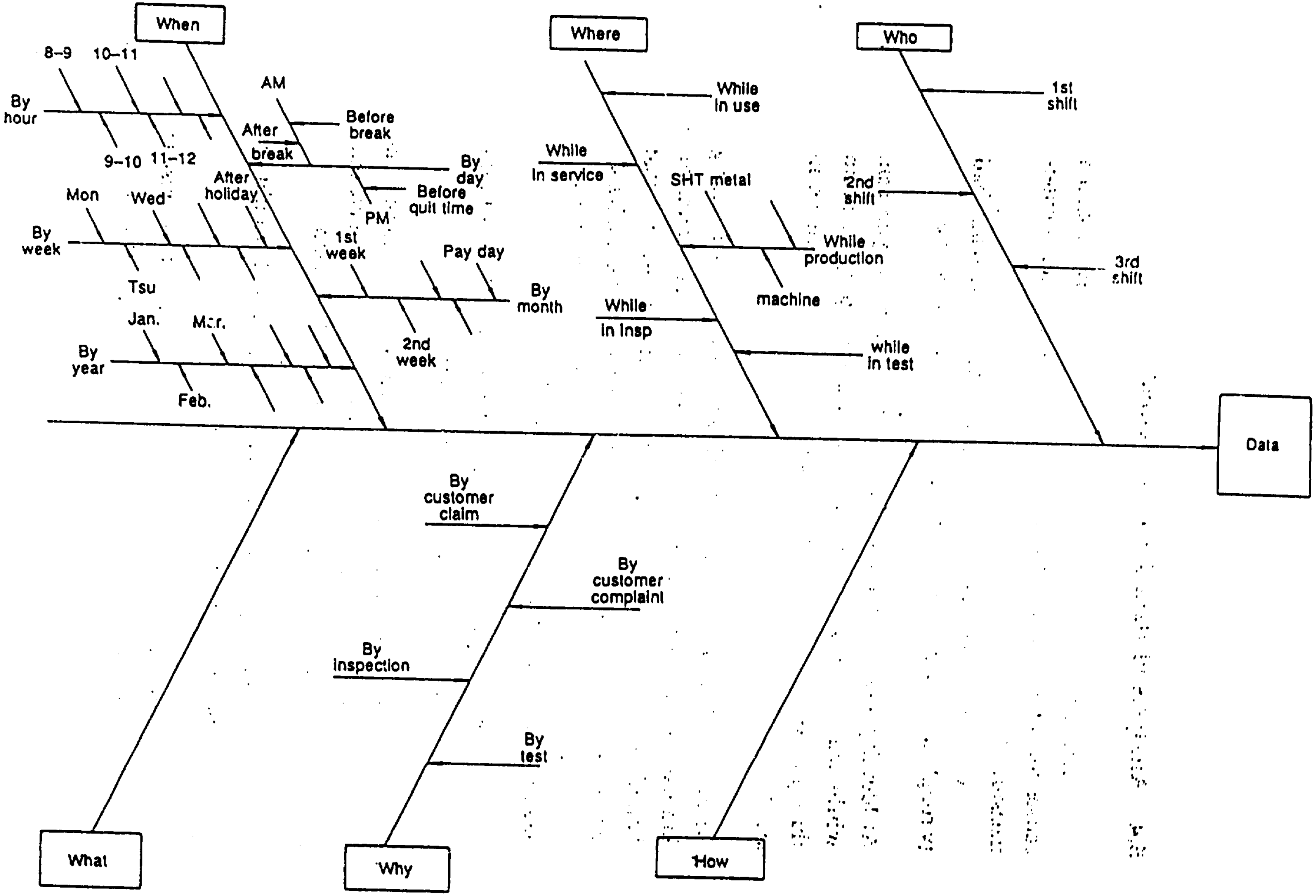


Fig. 6 Stratification of Data

5.4 Analysis of Data & Fact Obtained

Main objective for analysis is to identify any probable causes for solution and finally to isolate root-cause(s) for counter-measure(s).

In another words, to high-light where and what bad (wrong), and to clarify why they are bad (wrong) is its role.

A) Identify any possible probable causes as much as you can, while why dispersion is coming from are keeping in mind through 4M1E approach of fish-bone chart, that is as shown in fig. 7.

B) Some other causes beside 4M1E are also revealed during brainstorming session, as such customers using environment, boundary conditions, culture or, customs differences, etc., that any ideas are necessary to welcome and appreciate for analysis.

While identifying any probable dispersion causes, it is necessary to be careful for,

— Try to ask "Why dispersion be happened" 3–5 times, until probable cause(s) be identified.

— If you would take such as approaches "How to prevent dispersion", only brain-worked idea are popped out, not based on data analysis based on dispersion.

— To identify most affectable cause(s) which would directly influenced to dispersion.

— Reversely, to identify and to eliminate negative cause(s) for Dispersion is also important for simplification.

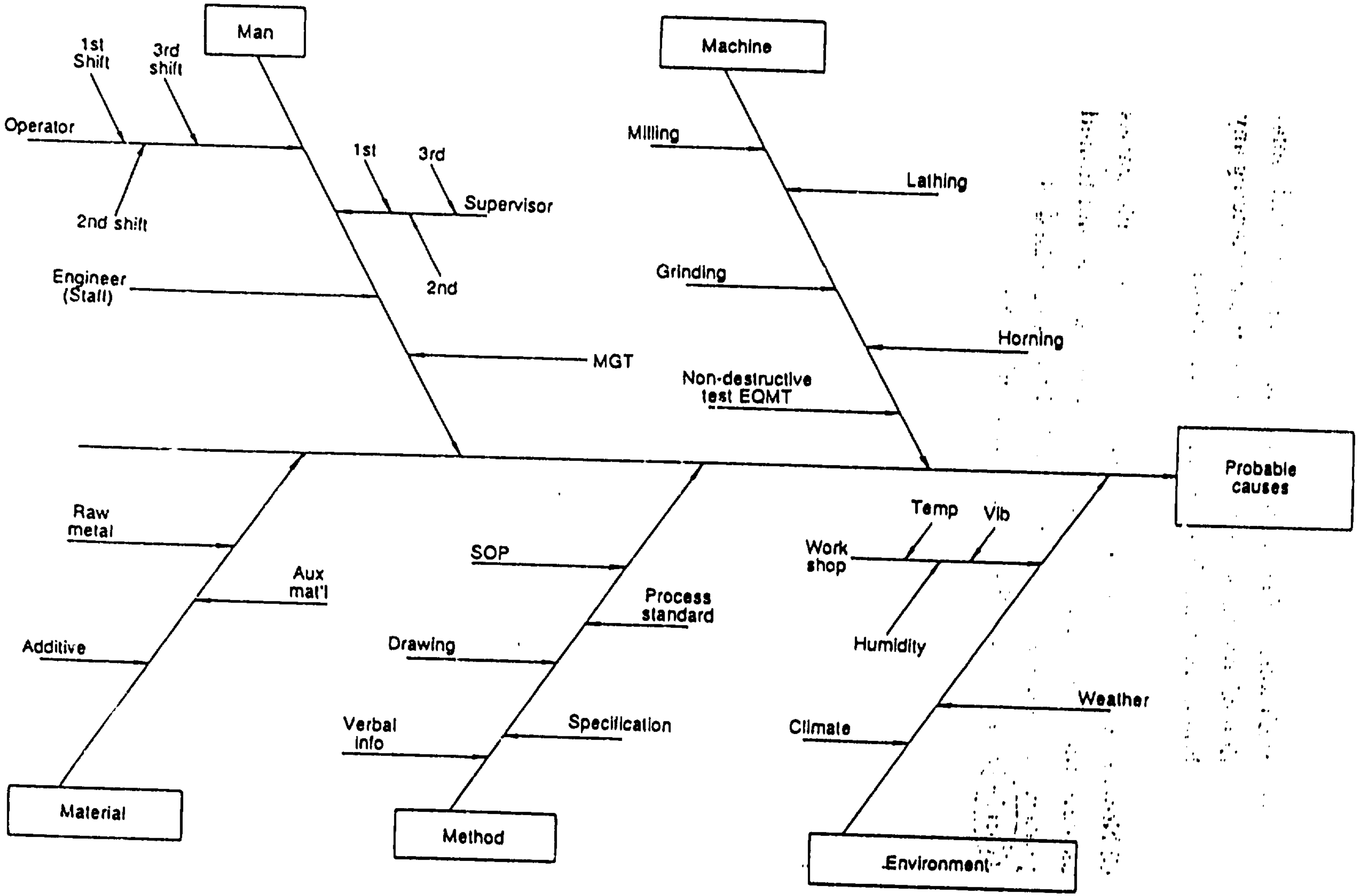


Fig. 7 Stratification of Cause Identification

— Such kinds of study must be continued on until isolation of root cause(s), is identified without changing any boundary conditions for dispersion causes.

C) Now, it is time to pick-up the-most affectable probable causes as candidates of root-causes through the above mentioned processings, such ones would be marked by underlined or Circled on the Fish-Bone Chart prepared before.

D) Isolate root-cause(s) among candidates of probable causes.

(1) To study and analyze past data or case-studying, and to identify which cause(s) mostly affect by studying 20–30 cases for justification.

(2) If any experimental test be avilable, its affects must be validated.

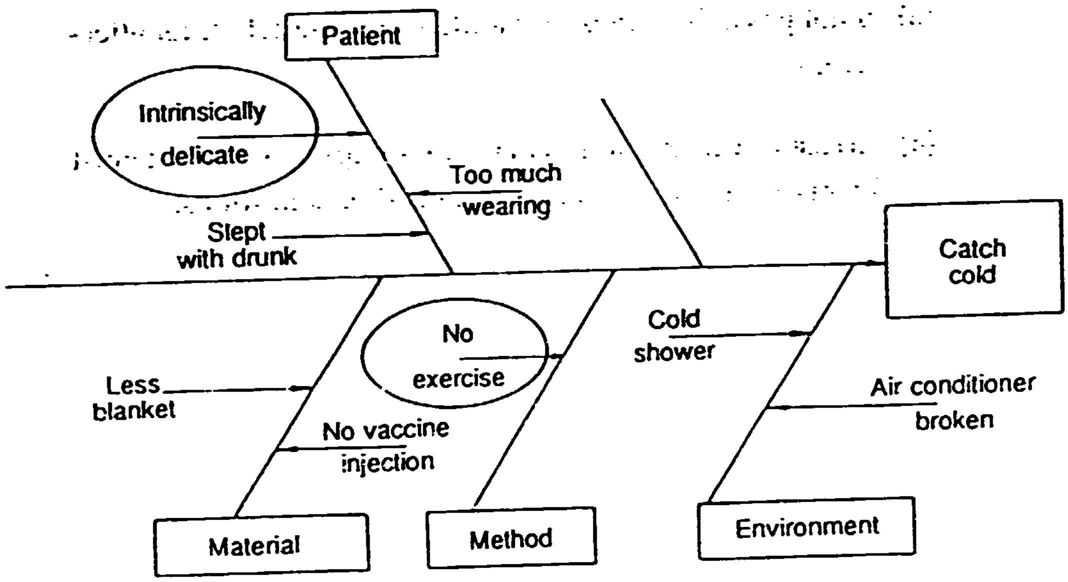
(3) If not possible, it must be validated by late action for effectiveness.

(4) In case any interaction is inevitable, experimental test must be performed without such interaction conditions.

5.5 Establishment of Counter-Measure(s)

(A) Establish counter-measure(s) for root-cause(s) isolated independently for

Remedial action	— For result
Recurrent preventive action	— For cause(s)



In case, the above case is analyzed as such,

Remedial action is	To take pill, to shot antibiotic injection, or to be in bed warmly
Recurrent preventive action is	To shot cold-preventive, and To health control practices

B) Deploy the same counter-measure to the population for improvement, which action is called as "Horizontal Deployment"

C) So far recurrent preventive action is taken for cause(s) to eliminate root-cause(s), its action might have side effect to other cause(s) as by-products – quality improved, but cost goes up high, and delivery date be late, or reversely cost reduced, but quality be degraded.

If such adverse effect is anticipated, it is better to apply the counter-measures partially and not all at same time, to confirm by-product.

D) Counter-measures established are necessary to notify and coordinate with any crganizations related prior to full implementations.

5.6 Execution of Counter-Measures

A) Every counter-measure(s) are necessary to be understood by every subordinates related and must be explained and disseminated with their intention and expected effectiveness with how to implement.

B) Execute the counter-measures physically on project.

C) Record the action taken and the result obtained on formats specified.

5.7 Evaluation of Result Obtained

(A) Compare the result obtained with the data or graphication prepared at Step 2 as shown in Fig. 8.

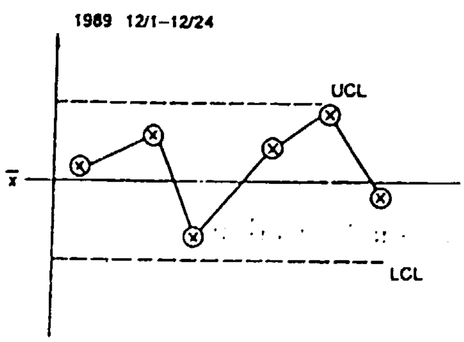
(B) Calculate the effectiveness for implemented counter-measures by monetarial value, through which every subcrdinates could be recognizable enough how much be contributed, and be motivated or challenged for future (next) project implementation.

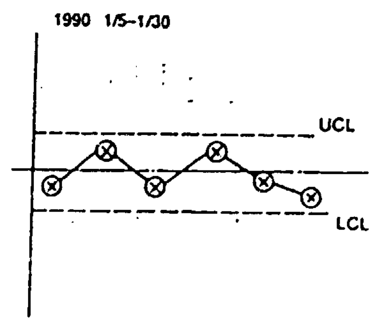
(C) Evaluate if intended goal is physically achieved as planned, and also secondary achievement is necessary to identify for counter-measures' effectiveness, by quantitative direct indications.

— When secondary achievement is remarkably evident, but primary one is low, the secondary is so much appreciated, and the primary tend to be neglected. This is most careful evaluation for why the primary one is not achieved as planned. But the secondary is effective. As for QC concept concerns, this could be evaluated as failure in planning and processing.

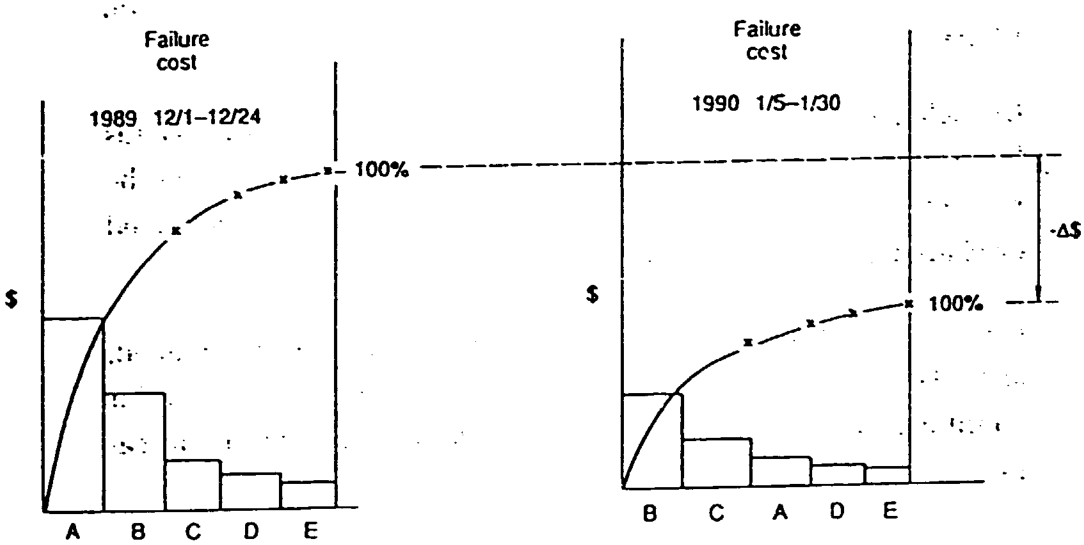
— When the results are not met with the goal, difference between result & goal is quite instructive information that in next project planning, the causes of such differences must be investigated to prevent from the same failure, as shown in Fig. 9.

By Control Chart





By Pareto



By Histogram

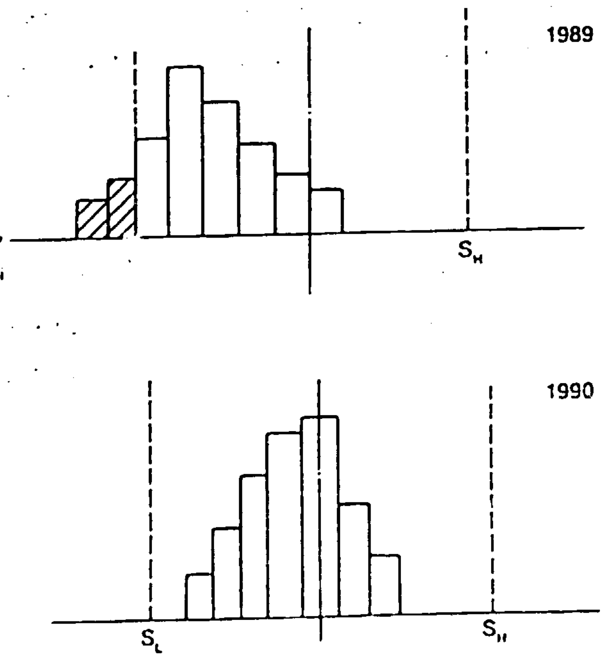


Fig. 8 Graphication of Status Indication

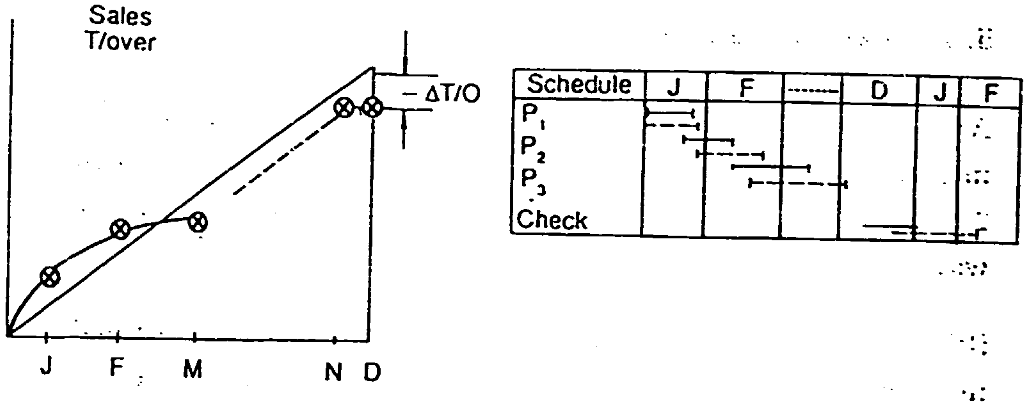


Fig. 9 Status Indication

D) As mentioned before, not only the secondary effectiveness, but some other qualitative, intangible or anticipated effectiveness are also necessary to mention at this stage,

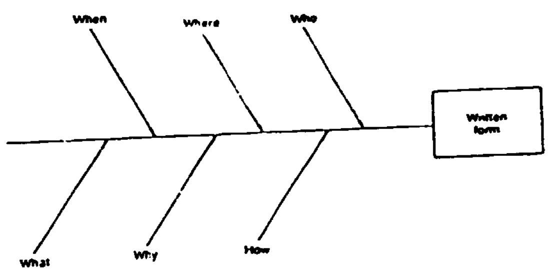
Qualitative effectiveness — Shorten time to take action, such as copying, tracing, etc.

Intangible effectiveness — Improve morale, improve empathy concept, etc.

5.8 Standardization

A): If project is not successfully achieved as planned, it could be interpreted as $\boxed{\text{Plan}}$ or $\boxed{\text{Do}}$ stages are something wrong that Step 2 to Step 7 are necessary to follow under QC story concept by way of "Way" concept.

(B) If project is achieved as planned, this counter-measure(s) must be standardized as a part of SOP (Standards Of Procedure) for implementing in daily routine-working area (Shops).
The counter-measures established are created by every technical expertises ideas and experiences into so popular and understand-able procedures for other unskilled employees improvement in operation. To standardize, 5W1H approach are most recom-mendable for fault-less establishment of SOP by



Why	—	Why necessary such changes into SOP.
Who	—	Who have responsibility for implementing of SOP, for checking or evaluations.
When	—	When SOP will be implementing.
Where	—	Which processing shop will be implemented.
What	—	What kinds of action (Operation) are necessary to implement.
How	—	How to conduct such action into operation.

(C) These consideration are necessary to integrate into SOP as written form,

if SOPs have been established, these input are to be called, "Revision"

if SOPs are not established, this action can be called, "New"

if Have been SOPs are necessary to delete, can be called, "Rescind"

(D) Whenever standardization are conducted, their effective date for implementation are disseminated to every organization related.

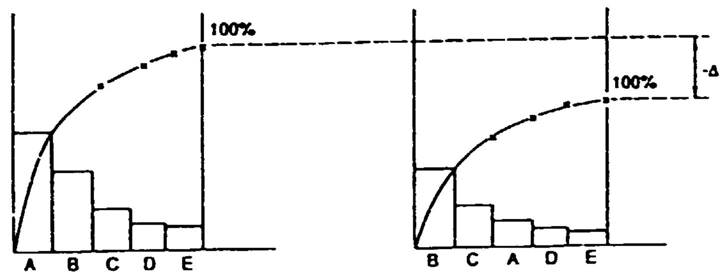
(E) After revised or new SOP are published, some kinds of education/Training program are necessary to install for full dissemination.

(F) After standardization, counter-measures established are necessary to consider if these are feasible enough to other similar operations for preventive actions.

(This is called as "Horizontal deployment", and is mandatory in TQC.)

5.9 Identification of Residual Problem and Future Program (Project)

(A)



Aforementioned example shows that "A" problem is now decreased but not zero yet, and "B" problem are now the worst situations.

(B) At this case, "A" problem is still going to correct until zero, and "B" is also to be zero are necessary to consider under "Vital Few" concept. "A" was a critical area to be solved, but after action, it has no critical today, nor "B" is the same.

(C) Usually, if the same project is continuing on sometime, people are tended to tire-of for such repetive action. Under such environment, it is recommendable to tackle another vital-few project at that time.

Also, residual area for "A" & "B" are better delegate to lower level people to tackle as their responsibilities for solution or wait and see their trend for some time.

(D) Established SOPs for improving project are necessary to conduct periodic check for their effectiveness are still existed.

(E) Overall self-examination for QC story processes of project is final action to be performed, as

— Project is exact vital-few, and valuable to tackle at this time.
— Project achievement processes are exactly following as scheduled.
— Project QC story are followed as planned.
— Analysis, root cause isolation and counter-measures are conducted by data appreciation concept.
— Project goal is fully accomplished as expected.
— No utilization for modified adjectives nor adverse for counter-measure establishment are fully implemented during whole QC story processings.
— How to establish for next project is always followed by after self-examination of the previous results.

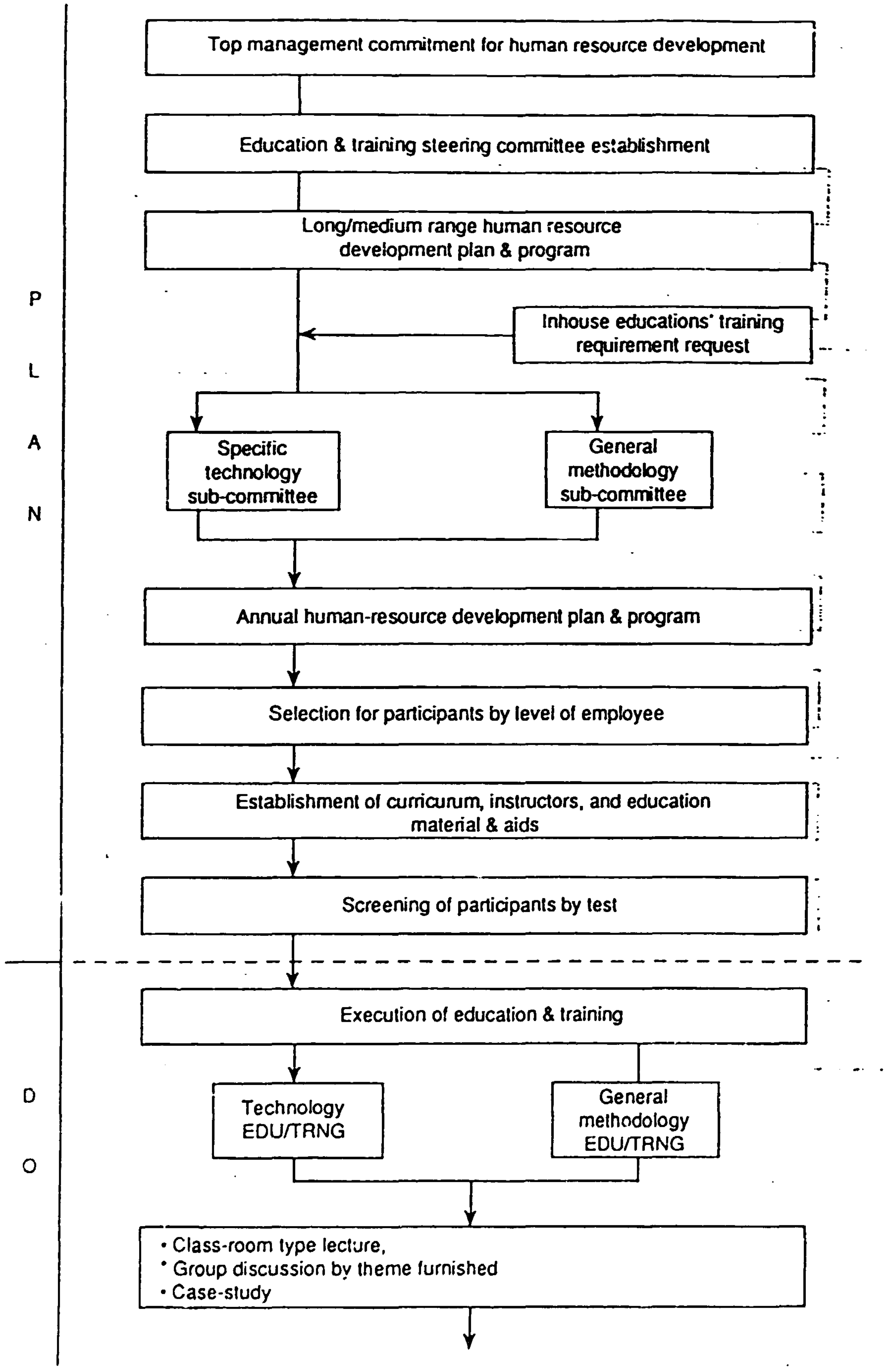
6. Education and Training

6.1 General

Employees education and training program are programmed by human-resources career development concept under top management's firm commitment which are explained in Fig. 10.

It's concept are necessary to be based on people-building as explained by old Chinese proverbs,

Bad farmer grows weeds
Good farmer grows rices
Better farmer cultivates rice-paddles
Best farmer builds human-beings.


Top management commitment for human resource development
Education & training steering committee establishment
Long/medium range human resource development plan & program
Inhouse educations' training requirement request
Specific technology sub-committee
General methodology sub-committee
Annual human-resource development plan & program
Selection for participants by level of employee
Establishment of curricurum, instructors, and education material & aids
Screening of participants by test
Execution of education & training
Technology EDU/TRNG
General methodology EDU/TRNG
• Class-room type lecture,
• Group discussion by theme furnished
• Case-study
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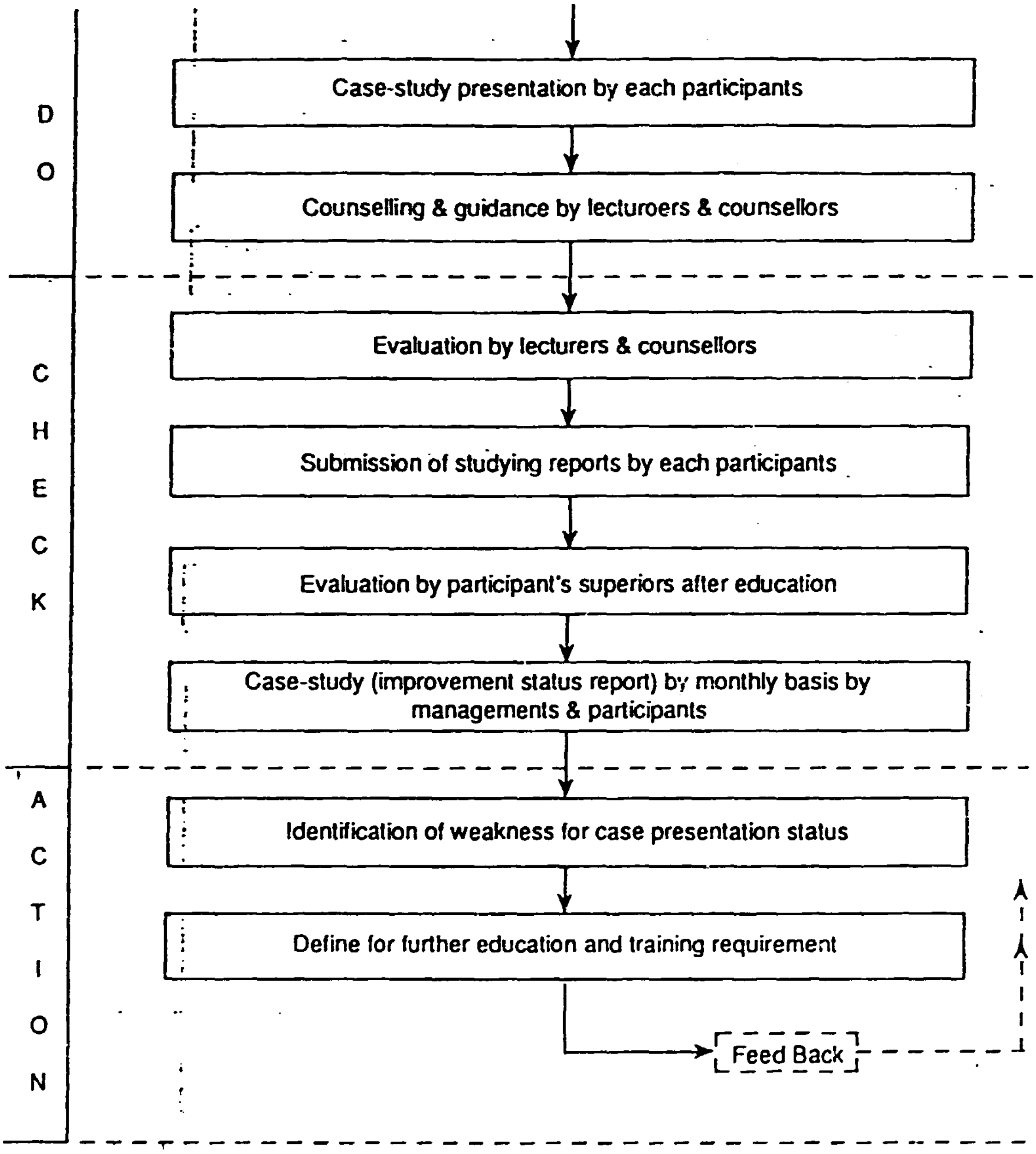

Fig. 10 Human Resources Education & Training Flow

Role of Education Office

1. **Establishment and Control of Company-Wide Human Resources Development System**

   (A) Understanding of Top Management Policy for Human Resources Development

   (B) Preparation of Human Resources Development System (Program & Plan)

   (C) Identification of Management & Supervisors Responsibility for their Subordinates Development

   (D) Organizing of Education System

   (E) Establishment of Education System Regulation and Standards

   (F) Estimation & Allocation of Educational Budget

   (G) Establishment of Long-& Medium Range Career Development Plan

   (H) Evaluation of job-Site Education Plans Established by Each Organizations and Follow-up

2. Identification of Education-Needs for Human Resources

(A) Identification of Education Needs or Weakness Based on Top Management Policy, Each Organizational Status & Weakness, and Technical & Technological Trends Analysis

(B) Prioritizing of the Above Finding depending on Criticality, Emergencyness and Inter-Organizations Analysis

(C) Decision of Physical Implementation Program

- i) Participants Selection
- ii) Instructor Selection
- iii) Duration
- iv) Budget
- v) Goals

3. Supporting and Counselling of Site Management and Supervisors

(A) Furnishing of OJT-Processing Procedures Tools Methods to each Responsible Management & Supervisors

(B) Consultation of OJT Implementation to Improve their Effectiveness

(C) Furnishing of On-the Job Site Education Material

(D) Consultation of On-the Job Site Education Implements

4. Establishment & Implementation of Education Program

(A) Establishment of In-House Class-Room Type Education Program by Level, Skill, Technics, Technology & Organization

(B) Establishment of Participation Program Organized by Outside Facility

(C) Establishment of Long-& Medium Range Programs for the Aboves

(D) Implementation of the Aboves

5. Establishment Supporting and Expediting of Self Development Concept within Employees.

(A) Campaigning of the Necessity of Every Employees Self-Development Program (People Building)

(B) Encouraging every Employees be joining and Participating of People-Building Program

(C) Pursuading Every Employees be Recognizing of People-Building Program through Personal Contacts

(D) Evaluating of Status and Trends for Further Developments

6.2 Example of Curriculum by Levels

(A) Recommendable Curriculum for Top & Sr. Management

(1) Role of Top/Sr. management in quality control
(2) Understanding & appreciation of SQC
(3) Quality control in planning and design stages
(4) Quality control in production stage
(5) Quality control in marketing and service stages
(6) Quality assurance
(7) QC circle activity concept
(8) World-wide status of QC concept implementation

(B) Recommendable Curriculum for Middle Management

(1) Relationship between business management & SC
(2) General concepts of quality control
(3) Organization and management of QC
(4) Quality assurance (at development, production, market, service, and QA system)
(5) Implementation, promotion & education of QC
(6) Execution of quality control
(7) Relationship between QC & reliability
(8) Supplier control
(9) Role of middle management for QC circle activity
(10) Statistical method orientation

(C) Recommendable Curriculum for Staff & Engineers

(1) Orientation of quality control concept
(2) How to summarize data obtained
(3) Probability & statistics

(4) Statistical inspection & estimation for attributed & variable data
(5) Control chart
(6) Sampling inspection
(7) Variable analysis
(8) Regression analysis
(9) Design of experiments
(10) Sampling method
(11) Reliability engineering

(D) Recommendable Curriculum for Supervisory Employees

(1) Orientation of quality control
(2) Role of supervisors for quality control
(3) QC 7 tools orientation
(4) Improving and maintaining in workshop under "Control" concept
(5) Quality assurance
(6) Inspection
(7) QC circle concept

7. Facilitator's Role

7–1 DESIRABLE FACILITATOR

1) TO FAMILIARIZE QUALITY CONTROL CONCEPT AND METHODOLOGY.

2) TO HAVE ENOUGH CAPABILITY FOR EXPLAINING A PROBLEM BY QUANTITATIVE INDICATIONS. AND ANALYZING SUCH DATA BY A STATISTCAL METHOD.

3) TO FAMILIARIZE EVERY WORK-FLOW AND WORK-JOB IN EVERY WORK-SHOPS.

4) TO KNOW EVERY EMPLOYEES BY NAMES.

5) TO BE ACCEPTED AS A TRUSTWORTHY PERSONNEL.

6) TO HAVE GOOD HUMAN-RELATIONSHIP AMONG EVERY EMPLOYEES.

7) TO BE GOOD LISTNER.

8) TO HAVE ENOUGH CAPABILITY FOR PERSUASION

9) TO HAVE ENOUGH CAPABILITY FOR TEACHING SOME METHODOLOGY.

10) TO HAVE ENOUGH CAPABILITY FOR RIGHT DECISION.

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11) TO HAVE A PATIENT MANNER.

12) TO HAVE A SOUND AND STRONG BODY.

13) TO STAY AS A DUMMY GENERAL AT ALL TIMES.

14) TO RECOGNIZE HIMSELF, WHEN BEING SUCCESS, SUCH TQC ACHIEVEMENT ARE TO BE GIVEN AWAY TO THE RELATED PERSONNEL OR MANAGEMENT, IF NOT, SHARE THE REPONSIBILITIES WITH CONCERNED PERSONNEL.

15) TO RECOGNIZE HIMSELF AS A FACILI-TATOR IS NOTHING BUT A MEDICINE FOR SICK. IF IT IS EFFECTIVE, IT COULD BE APPRECIATED. IF NOT, JUST CASTING BY A COLD LOOK.

16) IF POSSIBLE, TO BE A EXPERT IN A SPECIFIC FIELD (TECHNOLOGY).

IT IS CERTAINLY IMPOSSIBLE TO LO-CATE SUCH PERSONNEL, BUT FIND TQC MANIAC MAN AND EDUCATE THEM UNTIL HE CAN DEVELOP AND PROGRESS TO SUCH KINDS OF LEVEL UNDER LONG TERM PROJECT.

7-2 SPECIFIC FUNCTION AS TQC FACILITATOR

1) IF QC--STORY ARE FULLY UNDERSTOOD AND IMPLEMENTED AT EVERY ACTIONS. BY EVERY EMPLOYEES.

2) IF IDENTIFIING OWN'S WEAKNESS AND STRONG AREA WITH QUANTITATIVE DATA AND ESTABLISHING SOME CORRECTIVE/ SUSTAINING ACTIONS FOR IMPROVING/ MAINTAINING OF SUCH STATUS.
   ----- IF YES. ENCOURAGE FOR CONTIN-UATION
   ----- IF NOT. IDENTIFY WHY NOT. AND SUPPORT AND WORK TOGETHER FOR CHALLENGING THEIR AWAR-NESS FOR CONTINUOUS IMPROVE-MENT CONCEPT.

3) IF MANAGEMET IS SELF-SATISFIED FOR ONLY FOLLOWING OWN BOSS'S ORDER. WITHOUT OWN VISION NOR STRATEGY.

4) EVEN IF ESTABLISHING OWN POLICY AND GOALS. BUT THEY ARE ALWAYS SET RATHER LOWER CONSERVATIVE WAYS. WITHOUT ANY HIGHLY SELF-MOTIVATED AMBITIOUS ONES.

5) IF ZERO-ACCIDENT OR ACCIDENT PREVENTION ACTIONS ARE ESTABLISHED AND IMPLEMENTED UNDER QC-STORY CONCEPT.

6) IF EVERY STANDARD OPERATIONAL PROCEDURE (sop) ARE ESTABLISHED FULLY IMPLEMENTANBLE AND CORRESPONDABLE WITH THE PRESENT PHYSICAL OPERATIONS BY OPERATORS.

----- FLOW-CHART
PROCEDURES ── ARE AVAILABL
FORMAT

7) IF EVERY SOPs ARE ISSUED, STORED, REVISED, OR RESCINDED, AS SPECIFIED

8) IF EVERY MANAGEMENT ARE ESTABLISHED FOR SUBORDINATES MORALE MEASURING INDEXES AND IMPROVEMENT PROGRAMS.

9) IF EVERY MANAGEMENT ARE ESTABLISHED FOR WHITE-COLLOARS PRODUCTIVITY MEASUREMENT INDEXES AND THEIR IMPROVEMENT PROCEDURES.

10) IF EFFECTIVENESS OF QC TOOLS ARE EVALUATED.

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11) IF ANY REMARKABLE UTILIZATION CASE EXAMPLE OF QC METHOD ARE AVAILABLE IN TQC IMPLEMENTATION PROGRAM.

12) IF EVERY MANAGEMENT ARE PREVAILING FOR SELF-DEVELOPING PROGRAM UNDER THEIR OWN INITIATIVES WITH LONG TERM PROJECT.

13) HOW DEEPLY INVOLVE IN THEIR SUB-ORDINATES SELF-DEVELOPING PROGRAM AND SUPPORING BY EVERY MANAGEMENT.

14) IF EVERY MANAGEMENT ARE SUPPORTING FOR ESTABLISHMENT OF LIFE-WORK FOR EVERY SUBORDINATES.

15) IF EVERY SUBORDINATES' STATUS ARE WELL INFORMED AND ANY NECESSARY ACTIONS ARE TAKEN PROPERLY.

16) IF ANY PROBLEMS RELATED WITH HUMAN RELATIONSHIP BETWEEN SUBORDINATED ARE OBERVED.

17) IF ANY CONFLICT ARE OBSERVED BE-TWEEN SAME LEVEL OF MANAGEMENTS DURING HORIZONTAL COOPERATION WORK

18) IF ANY DISCONTENT OR GRIEVANCE IN EMPLOYEES MINDS ARE COLLECTED BY MANAGEMENT TO PREVENT FROM FUTHER OUTBREAK.

19) IF ANY REPORTS ARE BUBMITTED WITH ENOUGH DATA EXPAINED REAL STATUS.

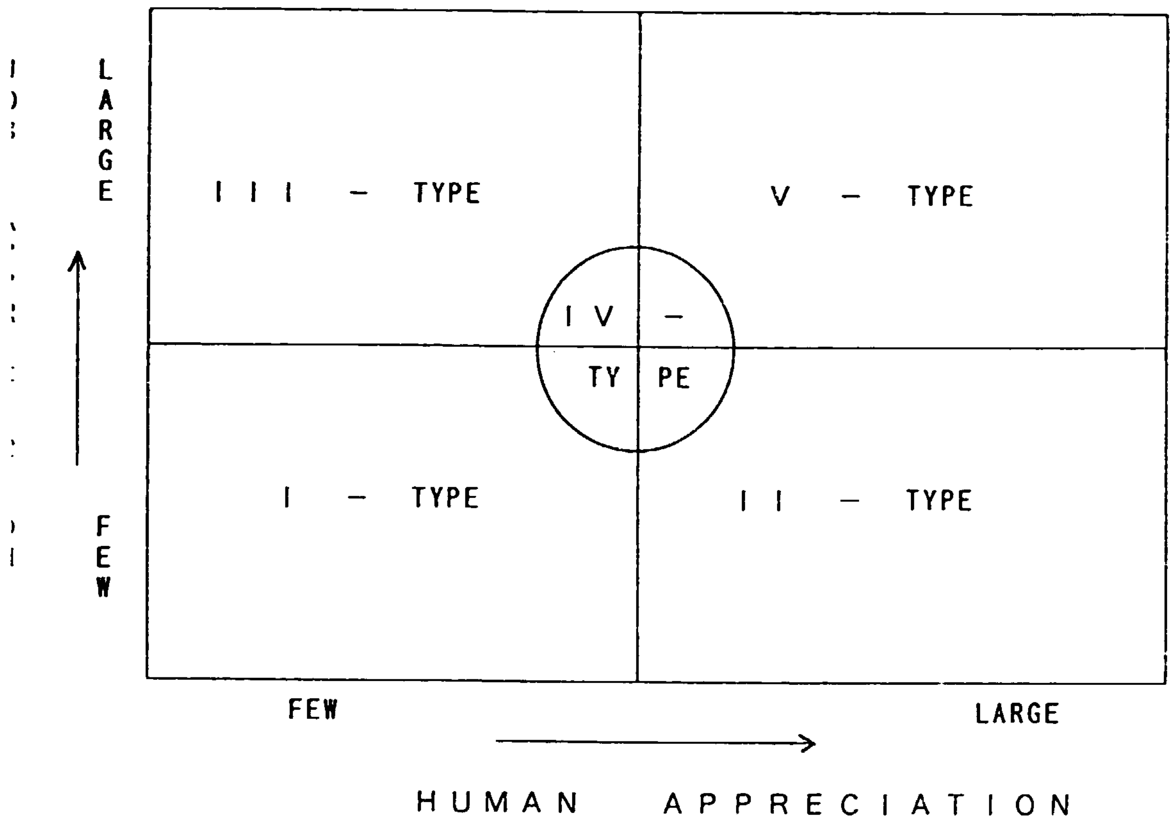
20) IF ANY CORRECTIVE ACTIONS ARE ES-TABLISHED BY BOTH OF REMEDIAL AND RECURRENT PREVETIVE ACTIONS, AND FULLY AND PHYSICALLY IMPLEMENTED.

21) IF NOT GOOD REPORT BUT BAD NEWS REPORT IS SUBMITTED (PRODUCTION FAILURE. CUSTOMER CLAIM OR COM-PLAINTS, OPERATOR ERROR, WARRANTY COMPENSATION, ETC) WITHOUT ANY DIF FICULTY.

22) IF EXPERIENCED WHEN SUBMITTED BAD NEWS REPORTS TO HIGHER MANATEMENT ANY EMBARRASSMENT HAS ENCOUNTERED.

23) IF EVER CHASING AND REQUESTING FO CORRECTIVE ACTIONS TO OTHER ORGAN IZATION OR PERSONNEL, WHILE NOT BLAMING OWN'S RESPONSIBILITY.

8. DESIRABLE MANAGEMENT



I -TYPE MANAGEMENT

-- LOW CONCERN FOR BOTH JOB AND SUBORDINATES

-- ONLY PERFORM OR CONDUCT MINIMUM DUTY OR RESPONSIBILITY

-- ALWAYS EVADE FROM CONFLICT, DIFFICULTY, FIGHT OR RESPONSIBILITY

-- EVEN REQUESTED ANY OPINION OR IDEAS OR SUGGESTIONS, ALWAYS EXCUSE FOR CONSIDERATION AND MORE TIME, BUT NOTHING PRESENT

-- DON'T WANT TO SEE HIS BOSS, ALWAYS HESITATE TO TALK

-- ONLY SUBMIT REPORT REQUESTED

I I -TYPE MANAGEMENT

- -- LOW CONCERN FOR JOB, BUT HIGH FOR SUBORDINATES
- -- PAY MORE ATTENTION FOR SUB-ORDINATES AS HUMAN-BEING, AND TRY TO COORPERATE WITH IN SHC BUT SO MUCH INTEREST FOR JOB ASSIGNMENT NOR ACHIEVEMENT
- -- TRY TO EVADE CONFLICT, BLAME C DIFFICULTY UNLESS HIS SUBORDI NATES ARE INVOLVED
- -- ALWAYS TAKE SUCH AS 'COME, COM DON'T HURRY TO CONCLUDE' TYPE SOLUTION
- -- STAY WITH " YES-MAN " WITH HI BOSS, AND NEVER SAY 'NO'
- -- INFORM ANY PROBLEM TO HIS BOS

I I I -TYPE MANAGEMENT

- -- HIGH CONCERN FOR JOB, BUT LOW FOR SUBORDINATES
- -- WORK-FIRST TYPE MANAGEMENT
- -- ALWAYS DRIVE SUBORDINATES HAF BY HIS OWN IDEA, AND NEVER CON SIDER THEIR PERSONAL NEEDS OF REQUEST
- -- NEVER ACCEPT OTHER'S OPINION NOR IDEAS, BUT RATHER SUPPRESS AND TALK AWAY
- -- SHOW HIS ACCOMPLISHMENT TO HI BOSS PROUDLY, AND TRY TO BE RECOGNIZED BY WITH BRAG
- -- SOMETIMES, OPPOSE TO HIS BOSS

V -TYPE MANAGEMENT

-- NOT 'YES-MAN' NOR RESISTING PARTICULARLY.

-- ALWAYS LOOK AROUND WHICH WAY IS THE BEST FOR OWN'S SAKE

-- MOST OF TIME, " YSE, IT IS, BUT --- " TYPE OF EXPRESSION IS HIS APPROACH

-- ALWAYS STAY AT COMPROMISING ATTITUDE

-- MOSTLY, TAKE SEVERE ATTITUDE FOR FOLLOWING CO'S REGULATION

-- TRY TO COMPROMISE BETWEEN JOB RESPONSIBILITY AND HUMAN RE-LATIONSHIP

-- MEDIUM CONCERN FOR BOTH JOB & SUBORDINATES

V -TYPE MANAGEMENT

-- HIGHEST CONCERN FOR BOTH JOB & SUBORDINATES

-- DELEGATE SUBORDINATES FOR SOME SPECIFIC PLANNING, SCHDULING AND IMPLEMENTING AND MONITOR-ING, IF FOUND SOMETHING WRONG, ACTIVELY SUPPORTING AND COUN-SELLING FOR HIS SOLUTION TO BE DONE BY SUBORDINATE HIMSELF

-- NOT BE DIRECTOR, NOR CONDUCTOR, BUT STAY AT ADVISOR OR BIG-BROTHER OR SISTER SITUATION

-- WHEN OPINION OR IDEAS AR' NOT CONSENTABLE WITH HIS BOSS, DE-BATE OR DISCUSS BY SYSTEMATIC AND SCIENTIFIC WAYS FOR RIGHT DECISION FRANKLY

2–WEEK TRAINING COURSE
FOR FCAV, BRAZIL
UNIDO PROJECT
(TF/BRA/92/B10, DP/BRA/92/004)

QC CIRCLE ACTIVITIES

Ichiro MIYAUCHI

COUNSELOR, J U S E

UNION OF JAPANESE SCIENTISTS AND ENGINEERS

– QC CIRCLE KORYO

General Principles of the Circle

QC Circle Headquarters, JUSE

– HOW TO OPERATE

QC CIRCLE ACTIVITIES

QC Circle Headquarters, JUSE

HOW TO OPERATE QC CIRCLE ACTIVITIES

JUSE

Chapter 1.

INTRODUCTION OF QC CIRCLE ACTIVITIES

1.1 Problems at the Time of Introduction

How can we start QC Circle Activities? There are many things to be taken care of. Where to begin?

This chapter describes a general procedure for introducing QC Circle Activities. These are the basic questions one is likely to face on introducing the system:

1) What steps and procedures to take?
2) How to organize a circle?
3) What should be done by foremen, assistant foremen and other shop managers?
4) Where to start?
5) Who should be the circle leader?
6) What and how should members study?
7) What actions should be taken by managers, supervisors and staff?
8) How to motivate circle people and managers?
9) It is easier to take an action if goals and targets are set. What kind of goals?
10) When things do not go as expected, what should be done?

The following sections explain how to initiate QC Circle Activities, and Chapter 3 describes problems which are likely to occur after the circle activities get underway.

1.2 How to Introduce QC Circle Activities

1.2.1 Procedure of introduction

(1) Observe existing QC Circles

QC Circle leader candidates should first of all observe how the existing circles are operated

1) Visit other workshops and plants in the company.
2) Visit other companies where QC Circle Activities have already been introduced.
3) Participate in QC Circle Conferences.
4) Participate in QC Circle Mutual Visits and Discussion of QC Circle.
5) Participate in training course, plant visits and QC Circle Consultation Forum.

(2) Listen to other people's experience of QC Circle

Talk to those people in the various workshops and plants in the company or other companies who have already experienced the activities. Listen to supervisors and staff members in charge of promoting QC Circle Activities, circle leaders and circle members. It is also useful to listen to those people who have given guidance to, and taken leadership of the QC Circle movement.

(3) Read books on QC Circle

There are a lot of publications on this subject in Japan and in several countries. Read and discuss them with the other members of a circle. The books recommended as an introduction to the subject are: "FQC" monthly magazine, "QC Circle Koryo (General Principles of the QC Circle)".

"FQC" carries articles on the operation of QC Circles, experiences, and educational articles on various techniques.

There is a feature article every month on, for example, cost, safety, work standards, materials and energy savings and other subjects of importance to any workshop operation.

"QC Circle Koryo" contains the basic ideas behind the QC Circle and desirable attitudes alluding to the operation of a circle. The basic essentials of the activity are described. Everyone is recommended to read this publication in order to understand the fundamental essentials. For further readings, refer to Appendix 6.2.

(4) Discuss

People who want to start a QC Circle get together and discuss how their circle, when it comes into being, can be operated. Then talk with supervisors, discuss with them what kind of roles supervisors can play in the QC Circle when it has been organized.

Then talk to those who are in charge of promoting QC Circles in the company and find out what kind of assistance they could provide in carrying out the activities.

(5) Do

1) Organize a QC Circle
   Workshop managers such as foremen and assistant foremen should take position of leader and try to operate.
2) Start some activities
   Try some meetings and work out some methods of cooperation, sharing the activity, application of techniques, selection of subjects (themes), study and taking steps towards solving a problem.

3) Initial experience and try-outs can be discussed among the members to improve the next course of activities.

/.2.2 Chances to introduce a QC Circle

If the appropriate stimulus is applied on introducing this new movement, QC Circle Activities will quickly gather an unexpectedly powerful momentum. But the way in which a person or a workshop is motivated differs greatly.

A successful initiation method for one workshop may not always be applicable in another. There is no single method which is universally applicable.

However there is no doubt about the importance of commitment among QC Circle leaders candidates. They can be motivated properly in the following manner:

1) By getting in touch with QC Circles outside of their own workshop in order to obtain a feel of the external environment. By being stimulated by listening to the voices of those people who can be considered their peers, and observing what the peer group members do and how they act.
2) By calling upon their supervisors and staff people and talking to them actively.
3) By trying everything himself and getting a feed of the activity, then communicate his experience to others and lead them.

The leaders or leaders-to-be must be so disposed that they take the initiative and set others on the move.

(ex.) Foremen A participated in a QC Circle Conference and became interested. He was confident that he could do the same if he tried. He initiated a QC Circle

of his own. Foreman B also took part in the same conference, but he was saying afterwards that the achievements presented in the conference were possible given a certain type of industry and a certain company which differed from his own workshop and hence, QC Circle Activities did not become active in his workshop.

/ .3 How to Organize the QC Circle

/ .3.1 Organization of the QC Circle

The "QC Circle Koryo" defines a QC Circle as

"a small group
to perform voluntarily quality control activities
within the same workshop."

The QC Circle is a small group organized voluntarily by all members of a workshop and carries out its activities continually so long as the workshop exists. The basic unit in a QC Circle is usually composed of a leader and members all of whom belong to the same workshop.

Figure 2.1 shows an example of such a basic unit.

There are variations as to basic form when the original circle has developed to a certain stage.

1) A circle is divided into smaller units. (Fig. 2.2)
   Workers under one assistant foreman are divided into two circles, for example, and choose a leader respectively.
2) A circle is divided into sub-circles and then further divided into mini-circles within a sub-circle. (Fig. 2.3)
   This example shows three levels of the QC Circle which can be given any name. Naming is left to your

choice. One way of describing those circles may be: a Parent-Circle which is composed of a foreman as a leader and assistant foremen as members: a Sub-Circle which is headed by an assistant foreman leading his subordinate workers: and a Mini-Circle organized by workers forming just a small group is headed by one of the workers.

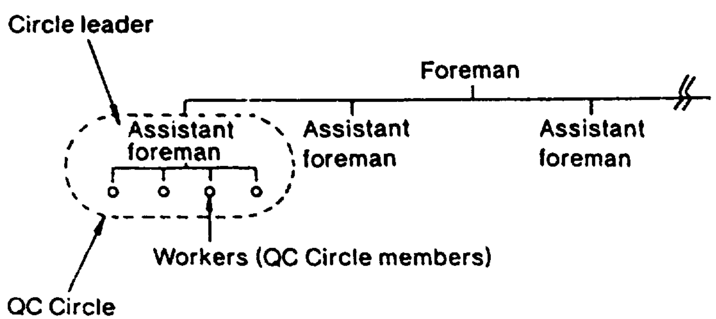


Fig. 1.1 The basic unit of QC Circle

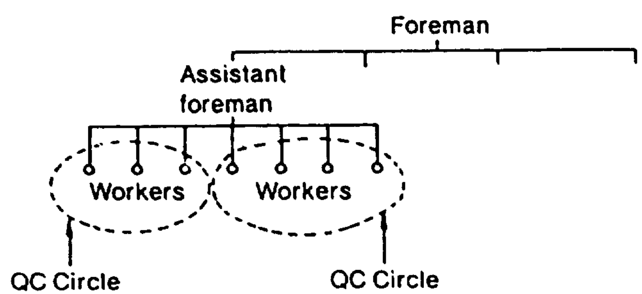


Fig 1..2 Divided QC Circle

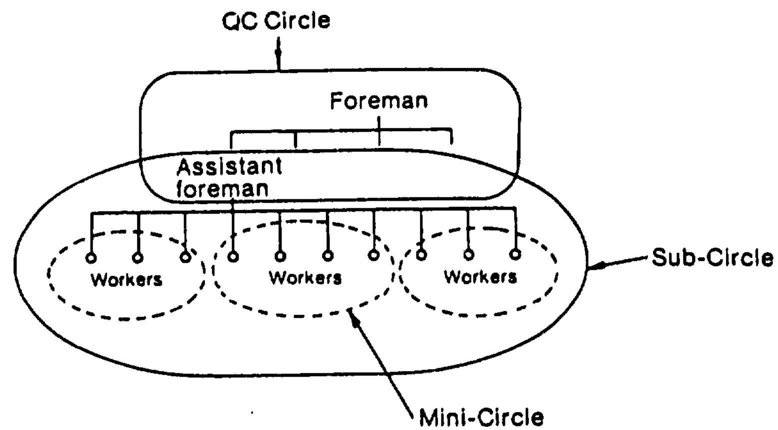


Fig.1.3 QC Circle, Sub-Circle and Mini-Circle

1.3.2 The size of a QC Circle

When a foreman heads a circle, the circle will be sometimes relatively large composed of thirty or sixty odd subordinate workers. But Sub-Circles and Mini-Circles shown in Fig.1 .2 and 1.3 are composed of three or seven people.

A desirable size of a circle is less than ten people in order to fulfill its purpose and carry out its activities properly. Ideally the number should be less than seven. A large group cannot meet easily and discussion is not effective.

In the case of a QC Circle composed of a large number of people, smaller active units should be formed for the sake of the daily activities. A meeting for all the members to communicate with one another can be held from time to time.

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1.4 The Role of Foremen and Assistant Foremen in Introducing the QC Circle

Workshop managers such as foremen and assistant foremen should take a lead in promoting QC Circle Activities. It is important for them:

- to get a feel of what QC Circles are all about, and
- to do everything by themselves and give an example.

Some useful suggetions:

- Organize a circle with one's immediate subordinates.
- Study the QC Circle Activities.
- Get in touch with other QC Circles outside of one's own company and bring this experience back to the circle as a subject of discussion.
- Discuss among the circle members how they will carry out their circle activities.
- Find a specific theme to work on and start analyzing a problem.
- Consider desirable relationships between circles and other levels and functions of the company organization such as managers, supervisors and staff.
- Study and apply the various techniques.
- Report one's experience to subordinates in the form of a case study and discuss it with them.
- Discuss such cases with foremen and assistant foremen from other workshops.

There are some precautions to take in carrying out the above-mentioned activities:

1) Leadership must be displayed, but two-way communication must be maintained. Be aware of the danger of a leader leaving everybody else behind.

2) Get everyone involved and encourage them to speak out. Give each member some kind of responsibility.
3) Talk to one another always. Respect the independent and voluntary will of each member.
4) Foremen and assistant foremen should already have experience of organizing and leading a QC Circle. There are some cases where they have no experience, yet they still let their subordinates organize a circle. Such a circle can easily go wrong, because people without experience cannot give the proper guidance required to carry out QC Circle Activities.
5) QC Circle Activities should be inseparably linked with day to day workshop activities so that members can feel that their work and QC Circle Activities are one and the same.

1.5 Selection and the Role of QC Circle Leaders

1.5.1 Selection of leader

A leader is the pivot and the driving force in a circle. It really makes a difference whether a circle can select a competent leader or not.

Leaders can be selected in the following manner:

1) In the initial period, workshop managers such as foremen and assistant foremen serve as a leader.
2) As the circle activities progress, a circle will be divided into smaller units composed of several workers. One of these workers with seniority, holding a supervisory position in the group may serve as a leader.

3) A circle can be organized with a small number of people who coopt a leader and rotate the position among the members.

(ex.) Rotation

In company M the leadership changes after each theme has been completed. They assign a theme to each leader i.e., Member A for safety, Member B for manhour reduction, Member C for reducing defectives.

I.5.2 Roles of leader

Leaders roles are, among others:

1) To integrate the circle.
2) To orientate and direct circle activities.
3) To facilitate cooperation among the members by getting everyone involved, speaking out and sharing responsibility.
4) To create favourable human relationships in his circle as a whole.
5) To adjust relationships with other circles and other levels and functions of the company organization such as managers, supervisors and staffs.
6) To cooperate with the Leaders' Meeting and/or QC Circle Promoter Meeting, etc.
7) To train the members on the application of engineering and QC techniques.

I.6 How to Select a Theme

A theme (subject, problem) should be selected in accordance with the experience and ability of a QC Circle.

1) Some categories of the theme are: how to carry out our circle activities.

(ex.) Members discuss the ways of holding a meeting, studying, selecting a theme, getting everyone to participate, evaluating achievements and cooperating with other circles.

2) Common and familiar problems in the workshop.

(ex.) Housekeeping of the workshop, improvement of the flow of information, record keeping etc.

3) Operational problems annoying workers in the workshop.

(ex.) Problems which can be solved within the workshop if the circle members take necessary actions.

4) Important operational issues in the workshop.

(ex.) Translating the president's policies and supervisors' policies into more specific policies for the workshop. Important control items in the workshop.

5) Problems spanning several workshop and processes.

(ex.) Problems can be often dealt with by joint circles when they involve more than one workshop, i.e. preceeding and following processes, indirect departments, other companies, suppliers, customers, distribution department, subsidiaries, associate companies, parent companies, etc.

Young circles tend to attempt projects seeking large effects which often give them a difficult task. Rather than jumping at big issues from the very beginning, easy, familiar tasks should be chosen to enable solution within a relatively short time. Young Circle should select a problem of your own responsibility and not to attempt problem of other's responsibility. A QC Circle will become competent step by step in the process of solving such problems and the members will learn to appreciate circle activities.

People will get bored with one theme if they have to work on it too long.

A theme that can be finished in three months is about right. If a subject seems to require a long time, it can be broken down to smaller themes each of which requires about three months, so that progress can be made in stages.

1.7 QC Circle Leaders Should Study Hard

In order to effectively fulfill the role of a leader mentioned in 2.5.2, he must study and learn:

1) QC Circle itself, i.e., what QC Circle is all about.
2) Techniques for solving problems, i.e., basic concept of QC and QC techniques, methods for control and improvement,
3) engineering techniques.

1.7.1 To study about the QC Circle

There are books about the QC Circle such as "QC Circle Koryo" and this book. Participation in QC Circle Conferences and Mutual Visits and Discussion is also a useful way to learn how to run a circle. One can also learn about the QC Circle by listening to people who already have some experience in the QC Circle, in other workshops of the same

company or from other companies. There are training seminars on the QC Circle both inside and outside of the company. QC Circle seminars sponsored by JUSE are shown on Appendix 6.1 as reference. A QC Circle can also arrange a study meeting to learn about the QC Circle from other circle members.

There are many circles which do not learn enough about the QC Circle Activity itself. QC Circle Activities are based on a philosophy and principles which are different from those conventionally found existing in the workshop. In order to assimilate new activities into the circumstances already prevalent in the workshop, everyone should understand the essence and the basic nature of QC Circle Activities. The basics should not be ignored. Books, seminars, process of mutual-development and actual practice of the QC Circle will help to create an understanding of what the QC Circle is all about.

1.7.2 To study the ways of solving problems through the QC Circle Activity

Circle leaders must learn ways to solve problems through QC Circle Activities, such as methods of controlling the process, how to achieve improvements (how to combine various QC methods), how to synthesize the ideas of group members (through brain-storming, for example), how to hold meetings, how to make everyone speak out, how to use case studies (how to learn from one another's experience through presentation meetings or from articles written in "FQC" magazine).

The strength of the QC Circle Activities exists not only in the spiritual aspect but also in the practical knowledge of techniques acquired by each circle member. QC Circle leaders and members should also study QC techniques for this purpose.

What kind of QC techniques should they learn? Circle leader and member must study 3 concepts and 7 tools. Some advanced QC Circle are applying IE (Industrial Engineering) and VA (Value Analysis) or VE (Value Engineering) in addition to the basic techniques.

(1) 3 concepts about QC:

1) Concept of Quality (Consumer oriented approach, the next processes are our consumers.)
2) Concept of Control and Improvement (Control Circle or PDCA. (Plan-Do-Check-Action) Refer to Fig. 4.1)
3) Statistical concept

(2) 7 tools for QC

1) Pareto Diagram
2) Cause and Effect Diagram (Ishikawa Diagram)
3) Stratification
4) Check Sheet
5) Histogram
6) Scatter Diagram
7) Control Chart and Graphs

(3) Engineering techniques

In addition to QC techniques, which must be studied by all circle members, engineering techniques directly related to day to day manufacturing activities and experiences should not be forgotten

In order to firmly establish QC Circle Activities in the workshop, engineering and manufacturing skills should also be promoted. There is no way to solve a workshop problem or to improve and control day to day operations without

many knowledge of engineering techniques. Circle members are encouraged to study and improve their engineering skills.

What are the engineering techniques?
There are three categories: Basics such as physics, chemistry, electric engineering, mechanical engineering; applied engineering such as production techniques, process engineering; and specific techniques such as welding, precision fabrication, operation of special facilities and sensory tests, all of which require experience, aptitude and skill. All of these categories are necessary for effective QC Circle Activities.

1.8 Management People Should be Effectively Utilized

Although QC Circle Activities are voluntary in nature taking place on the workshop level, the attitude and commitment at the various levels of the corporate organization will make a serious influence, especially when the circle is about to be introduced to the company or when the activities need upgrading. In such companies where QC Circle Activities are lively, the top and middle management as well as the QC staff have a positive attitude and are committed to QC Circle Activities. On the other hand, the activities will fare poorly and there will be a lack of cohesion amongst the various departments if the manager does not take a positive and unified stance.

The most important organizational positions for the promotion of the activities are immediate supervisors and QC promotion staff. Coordination with other departments closely related to workshop activities such as production control, labour, cost, safety, education and training, maintenance etc., also merits attention.

Circle leaders are advised to make the most of available organizational support, and coordinate the circle activities effectively with the relevant levels within the organization.

I.9 Problems at the Time of Introduction

The QC Circle will face difficulties at every stage of its growth; introduction, development and expansion. If problems at each stage are left unattended, circle activities cannot progress any further. Leaders must pay attention to the changing circumstances of the circle so that the activities should not flag. Whenever there is a personnel reshuffle or new entrants come to a workshop, measures should be taken to accommodate the change.

There are ten points which make for a successful introduction.

(1) The culture and climate of a company should be taken into consideration.

Since QC Circle Activities introduce a new approach to a workshop and revolutionize or make beakthrough time-honoured practices, introduction of such activities cannot always be smooth. The QC Circle Activity is not simply a method to carry out QC but it is a revolution in management concept. It is therefore not wise to neglect traditional practice and culture. The activities must be introduced carefully and promoted with patience and continuous effort, because it is not possible to change people's minds evernight.

(2) Patience, tact, and constant pitch

Allow enough time and try various ways to introduce the circle activities. Be patient and never give up. Try to go for-

ward always, but be tactful enough sometimes to give in on one point in order to gain two points.

(3) Get influential people involved.

There are seasoned veterans in any workshop who have both experience, skill and power. They have influence. Get them involved and to help promote the activities.

(4) Find QC Circle supporters in every level and position in the company organization.

If there is a group of people in the organization who are willing to support QC Circle Activities they can add to the propulsion of the movement. One often finds many such supporters among the management, staff and leaders of a company where the circle activities are successfully carried out.

(5) Formalities come later

It is troublesome to prepare a schedule format of activities, reports, QC Circle manuals and guide books from the beginning. Documentation and other formalities can be postponed until the activity starts moving smoothly. Though the extra work involved on formalities may not seem desirable, people will inevitably need and ask for documentation when the activities really get underway.

(6) Organization as an effective tool

Registration at the company or at the Headquarters and participation in QC Circle Promoter Meeting or Headers Meeting will also be helpful. But it is not too late to register or associate with groups voluntarily run by QC Circles, after the activities reach a certain level of maturity.

(7) Participation in mutual-development opportunities

Circle members should be encouraged to participate actively in presentation meetings, QC Circle Conference, Mutual Visits and Dicussion, study meetings and plant visits in order to learn from others and obtain stimulus for self-and mutual-development. Opportunities to participate should be given to as many people as possible rather than designating the same people every time.

(8) Everyone should experience the role of leader.

Leaders may be rotated. Members may take turns, serving as leader for a specified period of time, or for the duration of a project. One can learn through experience how difficult it is to be a leader and the experience is useful in the fostering of leadership qualities.

(9) Don't allow the leader to shoulder all the load

Sometimes, only the leader is very enthusiasm to promote QC Circle Activities. The leader must promote this activities that all the members should have problem-consciousness and participate and share in responsibility.

(10) Opposition

There will be adverse reactions to a forceful introduction of activities which attempt to spread the circle activities throughout the entire plant or company at one time. It is wise to start where it is possible and appropriate to start. Once underway, people will appreciate the experience and be motivated to participate in the activities.

Some people will be opposed saying that things have been going well without a QC Circle, that nothing will change by introducing the activities and that quality control technique are too difficult and also superfluous as people have been

making efforts to improve already.

In any case it takes time and patience to introduce the QC Circle. Try to find every opportunity to initiate and motivate reluctant or opposing people gradually rather than trying to pull them in by force.

Chapter 2

PRACTICE OF QC CIRCLE ACTIVITIES

2.1 How to Carry Out QC Circle Activities

2.1.1 Various ways and means

There is no universal way to carry out QC Circle Activities which apply to every company and every workshop.

QC Circle members must use their judgment to find the best method to carry out their QC Circle Activities. There is no single solution. The choicc is open to each circle, circle leaders and members to select from among the various possible ways to carry out the activities and to determine their course of action.

(1) There is more than one road to the top of Mt. Fuji.

People will find various ways to the summit, all of them will lead eventually to the top. The objective can be achieved by various ways and means.

A party to climb Mt. Fuji may include the aged. Then the best course is to climb up to a half of the way to the top by bus and to start walking from there. If the party is composed of fit and well people only, they may choose to walk all the way up from the most convenient starting point. The composition and various conditions of a group will decide the way to be chosen.

The ways and means to carry out the QC Circle Activities naturally differ depending on the conditions in a workshop.

(2) Every workshop is different.

Two apperently identical workshops may differ in details once specific conditions of each workshop are compared. This is the reason why there are many examples of failure as a result of trying to imitate ways and means successfully implemented in other workshops. Methods and procedures suitable for each workshop should be found by studying the features of the workshop.

Some of the factors to be distinguished in each workshop are; product line, production method, i.e., whether it is mass production or production to order, the category of workers, i.e., sex, skill, service period etc., corporate management policies and corporate tradition.

Learning from the examples of other workshops is a good approach, but each circle should be prepared to create its own methods and procedures.

(3) Hardships will give strength.

Successful QC Circles have not necessarily developed without a hitch. On the contrary they have become strong and unwavering through a history of suffering and difficulties.

There are more QC circles which experienced a thorny path than otherwise. For example, a key person of the activity, the QC Circle leader, is transferred to an other workshop or plant; a newly appointed supervisor of the workshop does not understand the QC Circle, which makes it difficult to hold QC Circle meetings; some people in the workshop are opposed to the QC Circle; ideas for improvement are depleted and many other difficulties arise.

Every time the members face a problem, and it is a different kind of problem each time, they will try togather their wisdom to overcome the difficulty. Such experiences will

give them more wisdom, the ability to solve problems, and strength. The more they have such experiences, and the more problems they overcome, the stronger they will become.

A well known legend of a Japanese warrior in the feudal age goes that he prayed God to send him plenty of severe hardships. We can assume that he wanted to temper his body and soul in order to become a fine warrior. It may not be easy to follow his example, but at least one should not be discouraged when faced with difficulties.

(4) An easy environment may spoil people.

A big tree grown in an easy environment without having been subjected to the vicissitude of nature is said to break easily when a storm blows hard.

The same principle applies to QC Circle Activities. It does not mean that one should ask for problems and disturbances in the QC Circle Activities. But one should watch for contentment within the status quo when every thing is going well, rather than takeing up problems of the same level of difficulty, one should always seek to tackle higher levels to further train oneself.

When things are flowing smoothly, one should not stay snugly in that environment, but seek challenges and set higher targets.

(5) Only one example out of many

It must be clear from what has been explained so far that there are a multitude of approaches to the QC Circle Activities. It is not possible nor useful to introduce all of the different forms and procedures.

Any approach introduced in this book does not even represent a common denominator, but is just one example. QC

Circle leaders and members are encouraged to use the example as a reference to discover and implement their own activities.

The procedure introduced in the following sections is a summary of ideas given by advisers of QC Circle Activities, from academic and industry, and questions raised by QC Circle members. The following sections will certainly be of great help in carrying out QC Circle Activities.

2.1.2 Fundamental factors of QC Circle Activities

Before describing the specifics of QC Circle Activities, the fundamental factors are outlined below in the order they appear in the life of a QC Circle.

(1) Leader's awareness of the fundamentals of QC Circle Activities and Leadership

The importance of the leader's role is obvious, as they are the fulcrum of QC Circle Activities.

Being the center of the activities, a leader must have a correct understanding and awareness as to the fundamentals of QC Circle Activities. He must be capable of exercising leadership over the other members of his circle. If a leader fails to acquire leadership through QC Circle Activities, the Circle, which should function as a group under his leadership, will suffer critical damage.

(2) Circle members should feel the necessity of activities.

Human nature is such that people in the workshop will feel and perform differently when they are told to do something from above and are obliged to do something because they have to, and when they feel it necessary to do something and take action voluntarily.

Circle leaders should make the members aware of the necessity to carry out QC Circle Activities. There are various ways to make them feel that way. Circle members could discuss and understand the significance of QC Circle Activities. They could observe active QC Circles in other workshops. For more details, reference is made in Chapter 2 "Introduction of QC Circle Activities" and Chapter 5 "Development of QC Circle Activities".

(3) Motivation

Knowledge about QC Circle Activities cannot in itself be useful to QC Circle members or to the company. When knowledge translated into action, knowledge becomes power.

The value of QC Circle Activities exists in action. QC Circle members should be "willing" to commit themselves. There are several ways to motivate them, among which the following three points merit special attention.

1) Exchange of information through discussion
   Each member of a QC Circle has his own knowledge and ideas about the QC Circle, though the level of knowledge may vary from person to person. Members may discuss and compare their ideas, which will naturally contribute to the orientation of their QC Circle Activities. Also people are stimulated and motivated to develop their ideas by talking to others. All the members will be able to confirm what the others are thinking and have more confidence in their own ideas.
2) Taking advantage of competitive human nature
   No one wants to be a loser. It would be problematic if such human nature is expressed to an extreme or channeled to a wrong direction. Fair competition, however, will have the positive effect of development and upgrading.

It is therefore important for each circle member to be aware that he is in competition with the other members of the same circle, the other circles of the same company and the circles of other companies.

3) Taking advantage of a desire for progress
Human nature desires constant progress and further development of one's ability. Among various methods to satisfy such a desire, QC Circle Activities could be considered as a strong and effective method.
QC Circle Activities should be operated to make the most of the desire for progress in the minds of each and every member of a QC Circle.

(4) Creating an environment to encourage voluntary activities.

Voluntary participation of all the circle members in QC Circle Activities, not as a response to directions or instructions from the organizational line and staff, is the key to the QC Circle Activities. Leaders must take the necessary measures to remove obstacles to voluntary activities by obtaining the cooperation of organizational line and staff and by creating an environment in which all the participants can freely and voluntarily take actions.

(5) Establishing goals

QC Circle Activities without a specific sense of direction will be not only ineffective but also damaging to the morale of circle members. Goals must be established to activate the movement. Goals will give the members a sense of progress and achievement. Achieving a goal will make people happy and also confident in their ability to achieve the next higher targets. A sense of achievement will also facilitate the planning of the next goal.

Care must be taken not to establish a goal beyond the reach of the members involved, as they might be discouraged and lose motivation if the goal is unachievable.

(6) Learning QC techniques

QC Circle derive their strength and effectiveness from the fact that circle members are equipped with a strong weapon, QC techniques. QC Circle Activities would not have become so widespread and effective if this movement remained just a spiritual one.

QC Circles solve workshop problems and implement improvements by applying simple QC methods. Circle members are encouraged to study QC methods, use them in their QC Circle Activities and achieve results.

(7) Creating "knots" in the activities

The bamboo has knots which give it resilience. The bamboo may bend but never breaks. The bamboo without knots is not worth its name.

QC Circle Activities must have "knots" or milestones where results are reviewed in order to maintain the resilience of the movement.

How can one create "knots" in the QC Circle Activities?

One way is to participate in QC Circle Conferences and give presentations in order to summarize the activities up to that stage. Both internal and external conferences can be used. Presentations can also be given when circle members to participate the Mutual Visit and Discussion of QC Circle of other workshops or other companies. Comparison with other circles will give a criteria for evaluating one's own circles activities and provide an opportunity to review the results. Another way of creating "knots" is to evaluate progress against targets.

(8) Evaluating QC Circle Activities

When a QC Circle pays attention only to marching forward, one may find one day that the circle has deviated from its proposed course and begun to act ineffectively. Circle leaders as well as members should stop from time to time or when certain problem has been solved to evaluate what they have done. In other words self-evaluation and self-criticism are due.

People can easily become emotional when criticized or even advised by others. They often become unreasonable and say "I know what I am doing, and yet I can't stop doing it this way, even if it's not the best way." To avoid this problem circle members can arrange an opportunity to evaluate the activities beforehand and then try to listen to one anothers' opinion sincerely. Then the members can find problems in their activities, recognize areas for improvement, and have better ideas for the next step without being carried away by emotion. Reviewing is a necessary first step if one is to take remedial measures and make progress.

So far the fundamental factors in carrying out QC Circle Activities have been described as one of many possible approaches. The next section deals with the specifics concerning each of the above-mentioned factors.

2.2 The Role of QC Circle Leaders

2.2.1 Leadership

There is truth in saying that the key to the success of group activities is the leadership ability required of a leader.

QC Circle is a group activity. Leadership ability in a QC Circle leader is essential. Circle leaders must, by all possible

means, aquire the ability to lead.

One must first answer the questions, "what is leadership?", and "what should be done to aquire leadership quantities?" But leadership is something which cannot be described logically or aquired through theory. The following is an attempt to give some guidelines on this subject.

(1) What is leadership?

"Leadership" is an English word, but it has been assilimated in to Japanese language. Translation of leadership into the Japanese language seems to blur the essential implications of this already Japanized word "LI-DA-SHI-PU". The closest Japanese words are "SHI-DO-RYO-KU" (an ability to lead), "TO-SO-TSU-RYO-KU" (an ability to control), and "SHI-DO-SHA-TO-SHI-TE-NO-SHI-KA-KU" (quality to be a leader).

"Leadership of a leader" in the context of QC Circle seems to imply something broader and less formal than the above-mentioned connotations. QC Circle leaders do not control members by giving commands and instructions backed by a leader's power and authority, but they have a different kind of power, namely, they can persuade QC Circle members without specifically mentioning what they actually want. In other words leaders can resort to "heart-to-heart" communication so that the members will be convinced that they should take actions toward the direction which leaders have in mind.

More simply put, leadership has the following aspects:

1) An ability to make others feel "Our leader has a reason." An ability to convince others.
2) An ability to make others feel "We should try for his sake," or "We've got to do it for him." An ability to acquire trust.

3) An ability to make others feel "We should imitate him," and "We should follow him."
4) An ability to make others feel that all circle members should cooperate in carrying out QC Circle Activities, participating in the meetings, thinking, and actively expressing their opinions in such meetings.

(2) Necessity and importance of leadership

A QC Circle is not just a gathering of people who enjoy each others company. QC Circle Activities have aims, and day to day activities have goals. Efficiency in the carrying out of activities is needed to achieve aims and goals. There are two things which are necessary and important, if QC Circle Activities are to be carried out efficiently.

1) The group power of a QC Circle.
2) The leadership of a QC Circle leader.

If each circle member acts as an individual and not as a member of a group, the power of the individuals will remain unchanged and will not multiply, however capable each individual may be. When those individuals get together as a group, the power of the group will be greater than the simple addition of individual power.

A heavy cargo of 200kg cannot be handled by one person, however strong he may be. But it is not difficult to move it when five or ten people cooperate.

The example was given for every one to understand advantage and importance of group power. There are numerous similar examples to be found in the workshop proving the necessity and importance of group power.

Group power is not limited to manual power, and means mental power too. An old saying goes, "Two heads are better than one." Wisdom of one person may not be enough,

but two or three people can talk and find the solution to a problem. Group power also means mental power.

QC Circle Activities enable circle members to supplement each other's ideas and generate a greater power than any one individual is capable of.

Can they generate such group power spontaneously, if members are prepared to gather their strength? It is not so easy. Suppose several people in a group work together to lift a 200kg cargo. If each of them tries in his own time to lift the cargo, they will end up using their power at different times. The cargo is too heavy for any one of them to move. Each will feel that the others are not using their power and will say "why should I?" The cargo will not move. It could be even worse, because there is the danger of an accident. If this group has a leader, others will follow the leader's calling of "one, two, three" and apply their power at the same time. The cargo is no longer heavy, when their power is put together.

Group power cannot be generated in a group without a leader or with a leader without leadership qualities.

The leadership of a QC Circle leader is indispensable to coordinate the power of individuals so that everyone will move in the same direction at the same time. There is no efficiency in an effort made in different directions and points in time.

(3) How to develop leadership

Good leadership can be displayed by a leader born with leadership qualities, or if the environment and the quality of circle members are favourable. But leadership qualities can be developed if a leader is prepared to make the effort. Any excellent quality will become rusty without attention. Leaders should always try to develop their leadership potential. There are several ways this purpose can be achieved:

1) A leader should have his own philosophy and vision about QC Circle Activities and communicate his belief to the other members.

   If a leader changes his attitude and ideas about QC Circle Activities very often, or passively follows circumstances, other QC Circle members will not follow his lead. A leader should have firm ideas about QC Circle Activities, a philosophy as a guiding principle to lead other members, and vision. He needs to communicate those ideas and visions to the circle members.

   "Vision" and "a guiding principle" may sound difficult, but these words simply mean "ideas" and "methods". Difficult words do not necessarily reflect difficult concepts.

2) Be the first to do.

   A circle leader must be the first one in a group to act and show a good example to members. Leadership will be lost if other members of a group think that their leader speaks well but takes no responsibility for his words. People often say that behavior and actions speak best. One action is worth million words.

3) Sincere efforts

   No one is perfect. There is nobody who satisfies all the requirements of leadership.

   More importantly a leader should make efforts sincerely to satisfy many of the requirements of leadership. Circle members will respect and trust such a leader when they sense sincerity and commitment.

Needless to say, a leader must learn various engineering and management technology, QC methods, how to deal with people, how to carry out QC Circle Activities ect., in order to adequately exert his leadership. While it is not necessary to know all these things, it is essential to make efforts to gather the knowledge if he wants to develop his ability to lead. Generally leaders master leadership through QC Circle Activities.

2.2.2 Teamwork

It is obvious that good teamwork is important for group activities. The concept of teamwork applies to any group activity. There is another terminology which should be distinguished from QC Circle, that is, a QC team. The word "teamwork" may sound as if it is associated with a QC Team. So new terminology such as "circle work" may have to be introduced to describe good teamwork in QC Circle Activities. Since such a new word may add to the confusion, a conventional word, "teamwork" will be used in the following paragraphs.

(1) Common aims

Good teamwork cannot be expected, if each member of a QC Circle has a different aim for circle activities. Each member will take actions toward different aims, and naturally teamwork fails.

Aims and objectives of operations may by necessity differ from one another. But the aims and objectives of QC Circle Activities described in Chapter 1 are common. When circle members understand the common aims and objectives of the QC Circle, they will be prepared to carry out QC Circle Activities with good teamwork.

If follows therefore that QC Circle members should thoroughly understand the aims and objectives in order to improve teamwork in circle activities.

(2) Understanding the basic idea behind QC Circles Activities

The basic idea behind QC Circles is the core and the highest order of philosophy regarding the QC Circle which one can reach by means of reason. Chapter 1 has already referred to the basic idea.

All the members of QC Circles should understand the basic idea and carry out their activities with confidence and belief. Teamwork will be generated from there. A circle leader must be able to understand and communicate the idea to other members so that they can also understand the idea. Or members can discuss this subject in QC Circle meetings.

It is important to establish the basic idea among the circle members.

(3) Improving communication

However bright one may be, and however willing one may be, one cannot do a fine job unless one is aware of what one is supposed to do.

Poor communication among QC Circle members, be it flow of information, notification, announcements, not only impairs teamwork but also causes emotional friction. People may say "why should I do this? No one informed me of this," or "why did you do this? You need not do this."

Teamwork can be improved through good communication, making every member aware of the aims and objectives of their circle and of each other's ideas and actions.

The best way to facilitate communication is to hold QC Circle meetings where the members can talk to each other. If meetings cannot be held, information can be circulated in a written form.

(4) Leadership of a QC Circle leader is necessary.

Teamwork will be greatly affected by the leadership of a key person in the QC Circle Activities, i.e., a leader.

As described in 3.2.1 circle members will be pleased to take the actions intended by a leader if the leader has leadership qualities. Teamwork will be generated spontaneously under good leadership.

(5) Time and patience to talk it out

Ten people have ten different faces and ten different opinions. Everyone acts differently. Under these circumstances different ideas and actions must converge in order to achieve the objectives of QC Circle Activities. Otherwise teamwork does not function. In order to resolve differences members should talk to each other and understand what others are thinking, and also divide jobs required of QC Circle Activities according to the characteristics of each member.

People may not understand the first time. But they will eventually understand if they talk it over many times. "Misunderstanding (GO-KA-I) will disappear after talking five times (GO-KA-I)," so the Japanese pun goes.

To talk with patience is a basic principle of management.

2.2.3 Leaders train circle members

Companies usually provide training for foremen and QC Circle leaders. But not many companies train all circle members directly. Leaders can train members or members can train themselves in their study meetings.

(1) Teachers (leaders) should have better knowledge and skills than students (members).

Water flows from high to low. Education is the same. A leader's prerequisite as a teacher is to have a higher level of knowledge and skill on the subject he teaches. If he does not posess such knowledge now, he can study and acquire it.

Circle leaders should be prepared to undertake that task and make the effort.

(2) He must study 5 to 10 times harder in order to teach.

He should thoroughly understand what he is going to teach. He has to study five to ten times harder than those who learn from him. Teaching provides a good incentive to study. QC Circle leaders are encouraged to take advantage of such opportunities to teach, and develop their ability and self-confidence.

3) Teaching by practical examples using QC methods

Members education should not be limited to teaching knowledge to a group of people. Teaching must take place in the workshop using data and actual jobs, so that methods of applying various techniques effectively in the workshop can be taught.

What is important is not theory but the application and effective use of the theory. Only a leader and circle members can use this approach to education as they are very familiar with their workshop. Rather than giving a lecture to a group of people, a leader should teach circle members by talking to them at QC Circle meetings.

4) Subjects

The essential elements of QC Circle Activities described in Chapter 2-7-2, the 3 concepts and 7 tools on QC methods Pareto diagram, causes and effect diagram, stratification and check sheet, should be taught first. In addition, if possible, the histogram, scatter diagram, x-R control chart, p control chart, and pn control chart should be taught.

2.2.4 Training of sub-leaders

Success or failure of QC Circle Activities depends greatly on the ability of a circle leader. His ability includes engineering and management technology as well as the techniques needed to operate a QC Circle and to deal with human relations. A good circle leader must study how to operate a QC Circle, and also acquire leadership through experience as a leader of a QC Circle. Leadership cannot be mastered only by study. It can only be learned through experience. A leader therefore must learn through experience the skills required in the running a QC Circle.

Leaders cannot be trained overnight. Leaders should try to train future QC Circle leaders on various occasions. As QC Circles merge or divide into joint QC Circles, sub-circles and mini-circles, the need for leaders increases. Training sub-leaders is important in order to educate a successor to foremen, assistant foremen and circle leaders and also to activate QC Circle Activities by dividing smaller circles such as sub-circles and mini-circles. Another merit of training sub-leaders is to prevent mannerism. If the same leader stays on, he tends to repeat already established patterns. Young and active sub-leaders can provide a check against mannerism.

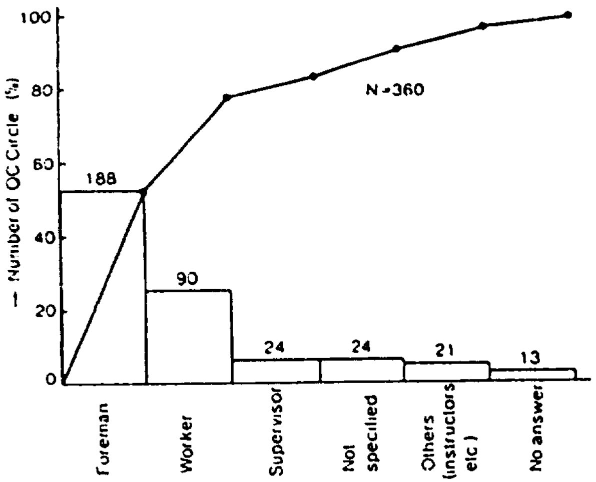


Fig.2.1 Positions of leaders

Figure 2.1 shows the positions of leaders in 360 companies as of 1976. The highest figure is 52%, "foremen" and the second is "workers". They are the core of QC Circle Activities. Supervisors account for 6%. During a transitional period, supervisors may play the role of leaders, but efforts must be made to shift the role to foremen and workers.

What should be done to train sub-leaders?

(1) Writing an instruction describing the role and functions of QC Circle leader.

It takes too long to train a leader only through experience. Leader's Job Instruction can be formulated and taught to candidates. At the same time a leader can delegate his authority to a candidate from time to time so that the acting leader can have some experience. In a short while candidates will acquire the necessary qualifications to become a good leader.

Who should write such an instruction? A circle leader can choose to consult with the staff, or he can do it himself. If he can do the latter, he has already become a full-fledged leader. Writing an instruction as to how his job is carried out serves two purposes. One is to have an instruction, and the other is that a leader has a chance to think about what he is doing and to review the way he serves as a leader.

(2) Rotating the leader's position

At the introductory period foremen, supervisors, usually become QC Circle leaders. Circle leaders develop themselves while serving both as the foreman and as the leader.

In order to train sub-leaders, foremen may retire from the leader's position and remain in the circle as an advisor or a promoter. One member of his circle will be appointed a leader or a chairman of QC Circle meetings. Members are thus given a chance to be trained as a leader or a sub-leader. After serving in this post for half a year or one year, they will return to the position of circle member and another member will have a chance to become a leader. Several sub-leaders can be trained in each circle by this method. Once they experience the leader's position, they will better understand the difficulties a leader encounters. When they return to the position of circle member, they will be prepared to cooperate with a leader and engage in circle activities positively. QC Circle can be smoothly run in this manner.

2.3 How to Hold QC Circle Meetings

2.3.1 QC Circle meetings

Some people misunderstand QC Circle Activities thinking they simply entail the holding of QC Circle meetings, but they are right in the sense that circle meetings are an essential element of the circle activities. Meetings enable the members to talk to each other, which is the basis of management and control, and to communicate information and to practise mutual-development.

As the nature of QC Circle Activities is such that it is desirable for all the members to participate in important meetings and present their ideas and opinions, there are several problems which arise in the way the meetings are held.

The following points should be considered in holding a meeting.

(1) How long should a meeting take?

The duration of one meeting depends upon how and when a meeting is held and the interval between meetings. Some circles may hold a five-minute meeting every morning when they are supposed to meet anyway according to a company practice of holding morning meetings. A thirty-minute lunch time meeting every Wednesday, two hours after working hours on the first Monday every month, or in other ways circle members think fit. There is no generally accepted way. Small and active circles may act smartly and hold meetings whenever they can, during short breaks in the workshop

when there is no urgent work to do, longer breaks on the lawn or bench in the garden, or taking lunch together on the same table. Every QC Circle should find its own way according to the conditions of their workshop.

Figure 2.2 shows the result of 1976 questionaire survey covering 360 Japanese companies on the duration of one meeting. The majority, 55%, hold a meeting lasting between 31 and 60 minutes, followed by 30% between 61 and 120 minutes.

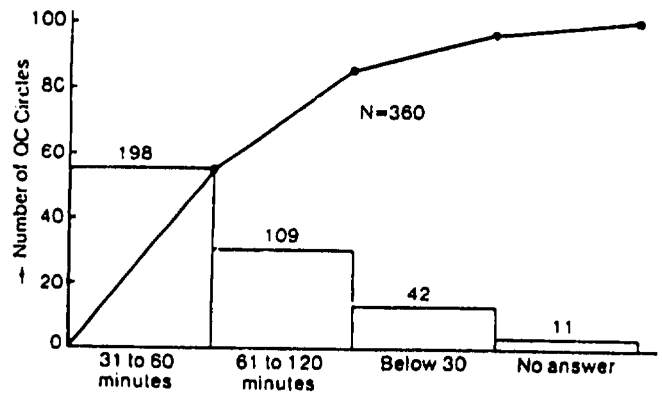


Fig.2.2 Duration of one meeting

Taking this data as a reference, most of QC Circle seem to hold a meetings of between 30 minutes and 120 minutes in duration.

However, as a general rule, every circle should try to limit the time of one meeting to two hours, and preferably to one hour.

(2) When to hold a meeting.

Some circles still hold meetings outside working hours, but most circles hold them within working hours. Among those meeting outside working hours, most circles meet after working hours. There are some circles which hold meetings during breaks or before work starts. One should remember that married working women and working students studying in evening classes at senior hight schools do not favour overtime.

The rule is to find the most appropriate time zone for the workshop and the circle.

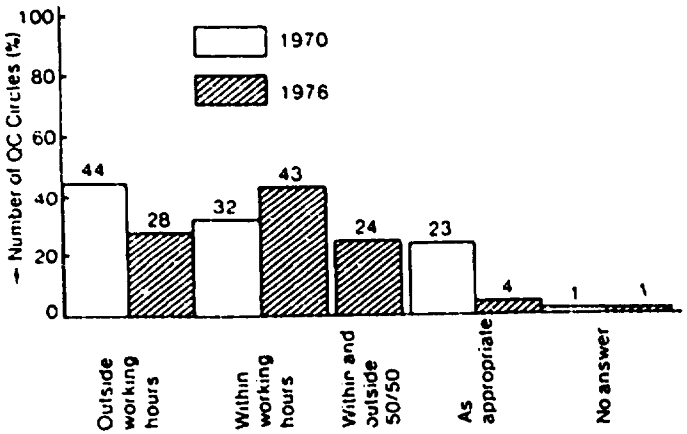


Fig. 2.3 When do you hold QC Circle meetings?

Figure 2.3 shows the result of 1976 questionaire covering 360 Japanese companies on when QC Circle meetings are held. "As appropriate", the second from the right, means no fixed pattern, i.e., choosing outside working hours or within working hours as appropriate.

Each circle can choose the most suitable time using the data as reference.

Figure 2.4 shows 1976 questionaire survey covering 290 Japanese companies on when QC Circle meetings are held, if held outside working hours.

"After work" accounts for the largest percentage, understandably because people can devote themselves to discussion without being disturbed.

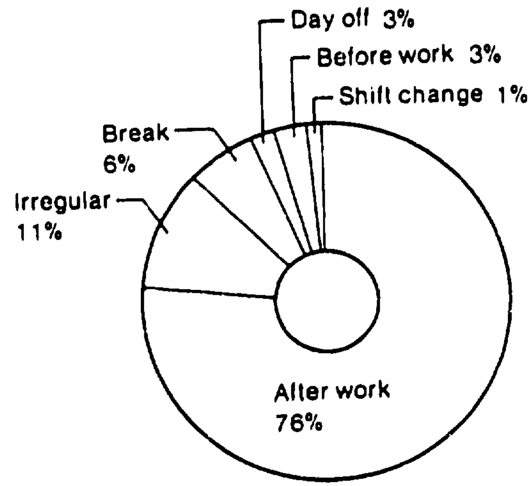


Fig. 2.4 When do you hold QC Circle meetings, if held outside working hours?

Figure 2.5 shows the 1976 survey result on how often in a month the meeting is held.

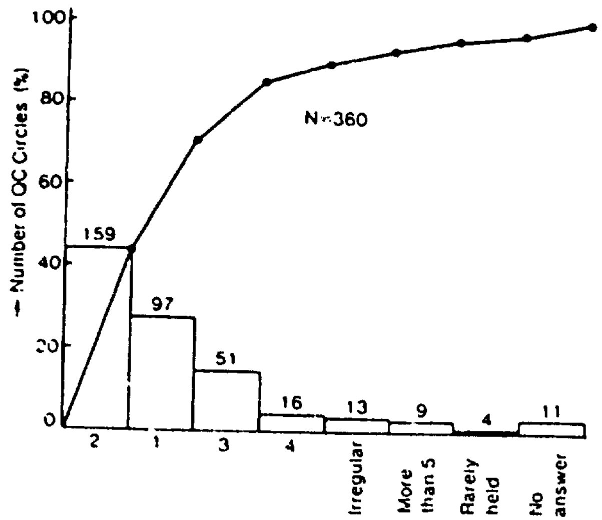


Fig. 2.5 Number of meetings per month

(3) Interval between meetings

Most circles hold meetings once or twice a month, though frequency varies depending on the theme or subject a particular circle is dealing with. Once or twice a month intervals seem adequate to allow each circle member enough time to investigate and study in between the meetings. Some circles prefer shorter intervals and shorter meetings to provide all the members an opportunity to share the results of individual activities as promptly as possible. One might think that a brief meeting of 5 or 10 minutes held whenever appropriate is not a "meeting". But the significance of a meeting lies in the substance however short the time may be.

Again the rule is to find a way most suited to the features of each QC Circle. However, frequency of the meeting is one of the measures of the level of activities. Active circles hold meetings more than once a week, while inactive circles may hold a maximum of one meeting a month.

The interval between meetings cannot be considered separately from how long one meeting takes. These two factors should be incorporated in planning the schedule of meetings. It is generally considered more desirable to hold short and frequent meetings.

(4) Allowances associated with QC Circle meetings held outside working hours.

QC Circle members will naturally be interested in whether they are going to be paid for circle meetings held outside working hours. Although QC Circle Activities are carried out voluntarily, the activities are related directly to the company, except that is the time used for studying. It follows therefore that some renumeration is due. However there are some companies which do not pay allowances. Moreover there are many QC Circles actively engaged in circle activities even if they are not paid allowances for participating outside working hours. There are some QC Circles whose members believe that they should not receive allowances for fear of losing voluntary of the QC Circle.

Allowances are paid under various titles; overtime, education allowance, meal allowance, refreshments allowances etc.

Figure 3.6 shows a 1976 survey of 322 Japanese companies on the question of allowances for QC Circle meetings held outside working hours.

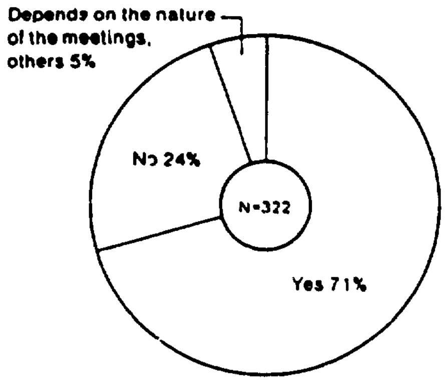


Fig. 2.6 Are allowances paid for QC Circle meetings held outside working hours?

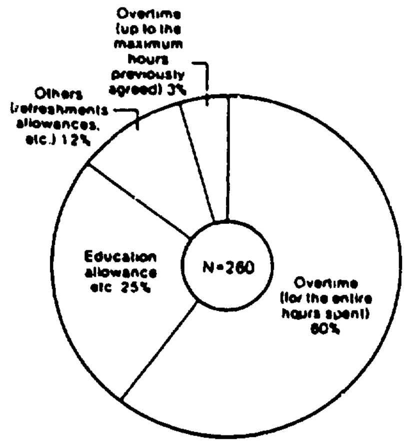


Fig. 2.7 Type of allowances if allowances are paid for QC Circle meetings held outside working hours

Figure 3.7 shows survey of 260 Japanese companies taken in the same year on the type of allowance paid for QC Circle Activities held outside working hours.

(5) Where to hold meetings.

As a rule, QC Circle meetings should be held in the workshop where the circle members work, because products and data to be used in the meeting are easily available. It is often said that "Quality Control is the control based on facts". It implies the importance of using data and observing products and the workshop problems on the spot.

However the meeting place need not be limited to the workshop as QC Circle Activities have many facets.

For example, a QC Circle composed of only women decided to hold their meeting one day in a downtown bar to spend the prize money awarded to their circle. The meeting turned out to be a great success and added momentum to their activities. Another circle which was becoming stagnant decided to hold their meetings in the houses of the members in turn, so that their QC Circle can be participated in by the members' families. This circle was later awarded a prize by the company president for their remarkable contribution.

These examples teach us how important it is to choose meeting places according to the circumstances.

(6) Should meetings be held when members are busy with work?

People often say they cannot hold QC Circle meetings, or cannot attend meetings even if meetings are held, because they are too much occupied with work. But they cannot excuse themselves for not holding meetings because they are busy.

The reasons are:

1) QC Circles are needed because people are busy.
It is understandable people sometimes feel they are too busy to spare any time for QC Circle meetings. If they continue to work without changing the methods and procedures of operation, there is no way to increase production without working longer hours. They must work harder in order to get higher wages, but might end up having no raise.
Operation must be changed in order to reduce time, increase efficiency of operation and therefore get a raise. QC Circle Activities become necessary for this end. Someone must take the initiative to break the vicious circle of not holding QC Circle meetings because they are too busy and keeping busy because QC Circle meetings are not held. Somewhere in this cycle the tide should be changed to a propitious circle by holding meetings and carrying out QC Circle Activities despite a tight work schedule. Supervisors and managers must assist in this effort and motivate circle members by squeezing out some time for them to engage in circle activities. QC Circle members should appreciate the importance of holding meetings and take positive steps to get the supervisor's assistance.
Once a meeting is held for a brief period, the next step will develop by itself.

2) Breaking the status quo. Never lag behind the progress being made in the world.
Productivity is increasing every minute. Maintaining the present level means a relative decline against competition.

Efforts must be made continuously to break way from the present status and keep progressing, to keep up with the progress in the world. How can he keep progressing if he winces when he is busy and says "QC Circle meetings cannot be held because work is tight". People should understand that QC Circle Activities are the driving force for the survival of a company.

3) Problems are everywhere.
In this changing environment where progress and development continues, new problems arise always in the workshop and the company. Those who cannot sense these problems cease to progress.
QC Circle is characterized by making people always aware through its activities of quality, problems and improvement consciousness. QC Circle meetings motivate the members to become aware of these consciousness.

4) Choosing a time for meetings convenient to the members.
Each member has a different schedule of his own. The differences will be magnified if QC Circle meetings are planned for after working hours.
A time for a meeting should be carefully selected by asking each member's opinion so that the time will be convenient for all the members. The meeting time should never be determined unilaterally for the convenience of a circle leader, or for some selected people. One good way is to set a certain day of the week so that every member should make efforts to plan their schedule accordingly.

(7) Meetings of a QC Circle whose members go to evening classes.

Not all the members can attend a meeting held after work. If some of the members go to evening classes at a senior high school, take courses, practise sports in a company sports club, attend a meeting at a cultural club of company etc., the following points should be considered:

1) Everyone should bear in mind that all the people in the same workshop are members of a QC Circle.
"If someone cannot attend a meeting, expel him from our QC Circle." This is not the correct approach. "All the members in our workshop are the members of our QC Circle." This is the basic idea on which a QC Circle should be managed.
2) Select a time when most members can attend.
A meeting can be scheduled for a break period or some selected time periods after work when most members can attend without much difficulty. However, attention should be paid not to inconvenience the majority for the convenience of a few.
3) Find some ways to communicate and share information with those who could not attend a meeting.
It is of course desirable to have everyone attend a meeting. If someone could not attend due to unavoidable circumstances, a QC Circle leader should contact him and ask his opinion verbally or in writing.
To repeat the basics, one should always remember that all of the members of a workshop belong to the same QC Circle.

(8) Meetings in a workshop operating a shift system

Many of the workshop working a two or three shift per day find it difficult to hold meetings together. The following points should be borne in mind.

1) Leader's meetings for better communication.
Generally each shift forms one QC Circle. The problem is how these circles can communicate with each other. One way of solving this problem is to hold leaders meetings to exchange information and opinions.
2) The theme or subject to be dealt with can differ form circle to circle or there can be a common theme.
If each shift forms one circle, there will be several circles in one workshop. The theme of each of these circles needs some attention.
There is no general answer, because each workshop should find its own solution to the question of theme selection. There is no general practice either. Some workshops choose to adopt a common theme for all the circles, and some others choose different themes. It seems, however, that it is more convenient to run a circle by choosing a different theme.
3) QC Circles communicate between shifts by means of a notebook, a blackboard, a memo etc.
Good communication is needed between QC Circles in a workshop working different shifts, whether or not they are working on a common theme. Good communication about the QC Circle Activities of each group serves many purposes. The vehicle for communication can be a blackboard, a notebook, or a leader or someone in charge can communicate verbally. Good communication has resulted, for example, in one fine cause and effect diagram jointly

made by two circles each of which contributed its own ideas to the diagram during its shift.
Items to be entered in a communication notebook are as follows.

1 the state of progress
2 requests for taking data
3 requests for opinions
4 data taken by the shift
5 cautions

2.3.2 Brain-storming

This word may not be familiar to QC Circle members. This method has been used often in recent years, in the workshop and by QC Circles who wish to reach good and reasonable conclusions. Once learned, it is not a difficult technique. It is an effective method which can be quite useful for QC Circle meetings to adopt.

Brain-storming is a free discussion based on the following rules.

1) Everyone should speak.
Brain-storming is one of the methods which allow all the members to speak in a QC Circle meeting, and to draw a valid conclusion. Everyone must speak, and everyone should be given a chance to speak.
2) Brain-storming induces ideas like a chain reaction.
One person's idea leads to the second person's idea, which induces the third person's idea. Ideas develop on this basis.
3) The theme or goal must be clearly stated.
The subject of the brain-storming session should be

clearly understood from the beginning, otherwise discussion may deteriorate into chatting and complaining. The goal of discussion should be roughly determined beforehand, i.e., the level and nature of the conclusion must be predetermined. It is also important to set the time for discussion.
4) Chairman and secretary must be elected.
For effective brain-storming a chairman must be elected to coordinate the procedure. A QC Circle leader is suitable for this position in the case of a QC Circle meeting. A chairman has the following tasks.
   1 To give everyone a chance to speak.
   2 To restrain people who speak too much.
   3 To encourage people to speak out.
   4 To restrain argument, at least at the beginning of the discussion.
   5 To draw a conclusion if possible.

A secretary takes a record of the discussion summarizing each opinion briefly. A good way of taking a record is to use a large sheet of paper stuck on the wall for everyone to see, and write in what has been said, in the order it has been said. The entire discussion can be summarized at the end.
5) Participation of all those having an interest in the theme.
It is desirable to have everyone who is interested in the theme to participate, however there is an optimum size of group, that is, less than ten. Six or seven will be more desirable in some cases. The number should neigher be too large or too small. On the other hand, unless everyone interested in the theme is

participating, essential parts of the theme may not be covered, a conclusion may be biased or those who could not participate might turn their backs on the findings.

6) Free discussion; one should not argue or oppose.
The most important rule of brain-storming is to allow everyone to think and speak freely, and never to deny or oppose what has been said by others.
In the presence of supervisors and engineers in the discussion group, people tend to hesitate to speak, or stop others in mid-speech saying, "that is not the case.". Free flow of speech will be stopped and the effects of brain-storming will be reduced greatly. A QC Circle leader who serves as chairman should restrain himself and not speak much to facilitate the flow of discussion.
Importance of free discussion, free from conventional ideas, must be emphasized in brain-storming.

7) Summarizing discussion in the form of a cause and effect diagram and Pareto diagram.
A cause and effect diagram is a useful means to summarize ideas and points raised by the group. The chart highlights missing points and duplication, and helps to sum up the discussion. A Pareto diagram is also useful depending on the nature of the problem.

8) Selection of important causes
There are many causes (factors) contributing to a certain effect. Discussion should be limited to some important causes. It is best to select these through discussion among the participants of the brain-storming session.

9) Determining the trial procedure of important causes.
Quality Control is meaningless in QC Circle Activities so long as it remains only as knowledge. Action gives meaning. Any conclusions drawn from brain-storming must be implemented. The conclusion relates to important causes contributing to the effect. These causes must be taken care of in relation to the conclusion. The procedure for trial actions should be determined according to the principle of 5Ws 1H.
   1 Why?
   2 What?
   3 Who?
   4 When?
   5 Where?
   6 How?
Actions are taken in consultation with supervisors and staff on how to try the ideas out, to deal with important causes. If the effect is improved as a result of this trial, brain-storming completes its cycle. If the effect was not improved, brain-storming is repeated on the same subject.

2.3.3 Selection of a theme

Whether a theme is adequate or not affects the operation and the results of QC Circle Activities.

There are some QC Circles which have lost momentum on the way because the theme was either too big or too difficult for them.

The following points should be borne in mind when selecting a theme.

(1) Familiar themes

A theme which is familiar to the members will interest them. Active contribution by all can be expected, then a problem can be more easily solved. All the members willingly take part in QC Circle Activities. The circle will progress and become active.

(2) Common themes

A common theme can involve everyone. Everyone has something to say.

Figure 2.8 shows a result of the 1976 survey of 360 Japanese compaines on "the categories of themes". Table 3.1 is a breakdown of each category. This data will give some hints for the selection of a theme. (N=839, because each company mentioned several themes.)

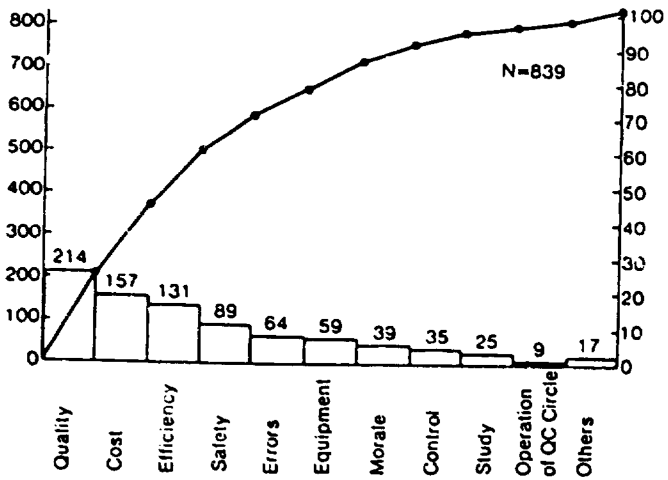


Fig. 2.8 Categories of theme

Table 2.1 Breakdown of Each Category

1	Quality	reduction of defectives, quality improvement, prevention of complaints, reduction of out of control, reduction of dispersion, holding the state of control
2	Cost	reduction of expenses, reduction of manhours, effective use of time, reduction of time, material savings, maximizing use of material
3	Equipment	failure prevention, automation, imporvement of jigs and tools, improvement of layout, labour saving
4	Errors	careless mistakes, accident, inspection errors, information errors
5	Efficiency	output, working time, timing, production control, improvement of delivery, procedure streamlining
6	Control	standardization, action, control points, prevention of recurrence, audit, severe control
7	Study	method of holding meetings, QC education, technical training, upgrading, plant visits
8	Safety and environment	fatigue, good arrangement, improvement of environment, safety and health, pollution

9	Morale	human relations, enhancement of morale, dialogue with supervisors, activation of suggestions, reduction of absenteeism
10	Operation of QC Circles	mutual visit, QC Circle conference, selection of a theme, organizing, all participation, joint circles, method of holding meetings, men vs women, shifts, age difference or a wide spectrum of age, difficult experiences, part-time workers
11	Others	policy, the way it should be, familiar problems, improvement of clerical procedure, understanding the present status

The ideal state of QC Circle Activities is to have everyone participate and contribute his opinions. Individual will should be reflected in the group will. All the members should be able to accept what has been decided by the circle. A good start takes us half way to success. Once an appropriate theme is selected and QC Circle Activities start running on the right track, even a theme which is not common to all the members can be handled. Step by step they can challenge themes of a higher standard.

(3) Simple themes

Everybody knows that the easiest equation should be answered first in a written examination. If an examinee starts with a difficult question, he may not be able to answer a single question, or he will become nervous and unable to adequately solve even the easy ones.

QC Circle members are strongly advised against tackling difficult problems from the very beginning, for they might lose confidence.

QC Circle Activities gain momentum when good results are achieved on simple themes, self-confidence will make it possible for the circle to handle difficult themes.

(4) Examples of the theme

The name "QC Circle" should not necessarily limit the area of themes to Quality Control. Needless to say, quality questions should not be forgotten, but many other problems of the workshop can be taken up as a theme.

The following are examples of such themes.

1) bright and happy workshops
One third of our life is spent on the workshp. It is unfortunate for the workers if their workshop is dark and unpleasant. It is a good idea to study the theme, "how to create a bright and happy workshop"

2) operation of a QC Circle
This theme can be taken up many times, as this is a basic theme in the running of QC Circle Activities.

3) quality issues
This is at the heart of QC Circle Activities. Any workshop has quality problems which can be used as a theme of QC Circle Activities; prevention of defectives, improvement of yield, improvement of quality, prevention of errors, fool-proof devices, improvement of operation etc.

4) safety issues
"Safety first" implies the importance of maintaining safety in the workshop. Accidents causing casualties must be avoided at all cost. There are many safety issues in the workshop such as good arrangement.

5) cost issues
Effect is often measured by a reduction of costs. A QC circle which cannot understand what cost means, or which cannot calculate cost will be in trouble. Cost is often used as a measure to evaluate the results of QC Circle Activities. Cost is an important subject to be taken up as a theme.
There are numerous issues related to cost in the workshop such as prevention of defectives, improvement of yield, saving of expenses, reduction of man-hours and maximizing use of material by better material layout.

6) operational efficiency and improvement
There are areas for improvement everywhere. One should open one's eyes and be prepared for improvement. Potential areas are, better yield, different operation methods for increased efficiency, reduction of waiting time by better production control and introducing jigs and tools or mechanization and automation of manual work.

7) manufacturing conditions
Control and improvement of factors related to manufacturing such as operators, materials, parts, machines, jigs and tools, instrumentation, operation methods, measurement and sampling methods and operation environment
Work on the shop floor is the governed by these factors. The basic concept of Quality Control, or Control is an attempt to achieve a good result by keeping these factors (causes) under control. Control and improvement of these factors are the central themes of QC Circle Activities.

(5) How many themes, i.e. problems, should be solved each year.

There is no definitive number, because it depends on how big and how difficult the problem is, how often meetings are held, how long one meeting takes, etc. However it is desirable to solve two problems, and four if possible, each year.

Figure 3.9 shows a result of the 1976 survery of 360 Japanese companies on, "the average number of themes solved over a year".

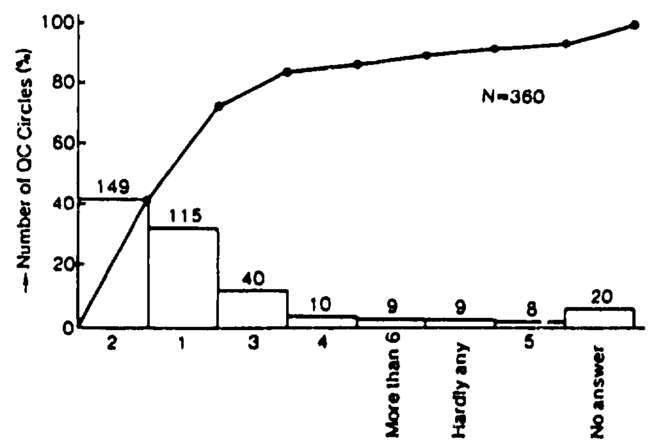


Fig.3.9 Number of themes solved over a year

(6) Registration of a theme

A theme, i.e. a problem, should be solved by the QC Circle which selected the theme. However it helps the circle to solve the problem if the theme is officially registerd with the company.

Registration makes the theme known to the relevant organizational levels and positions. Also, QC Circle members will be motivated to carry out their activities according to a plan and schedule because they are aware the their theme has been officially registered with the company.

(7) Reporting completion of a theme

A theme will be terminated when the expected goal has been achieve. Circle members should confirm completion of theme and announce termination. It is advisable to report to the relevant organizational levels and positions that the theme has been completed.

Figure 3.10 shows an example of QC Circle Activities' report form. This form is used both for registering a theme and reporting relevant organizational levels and positions.

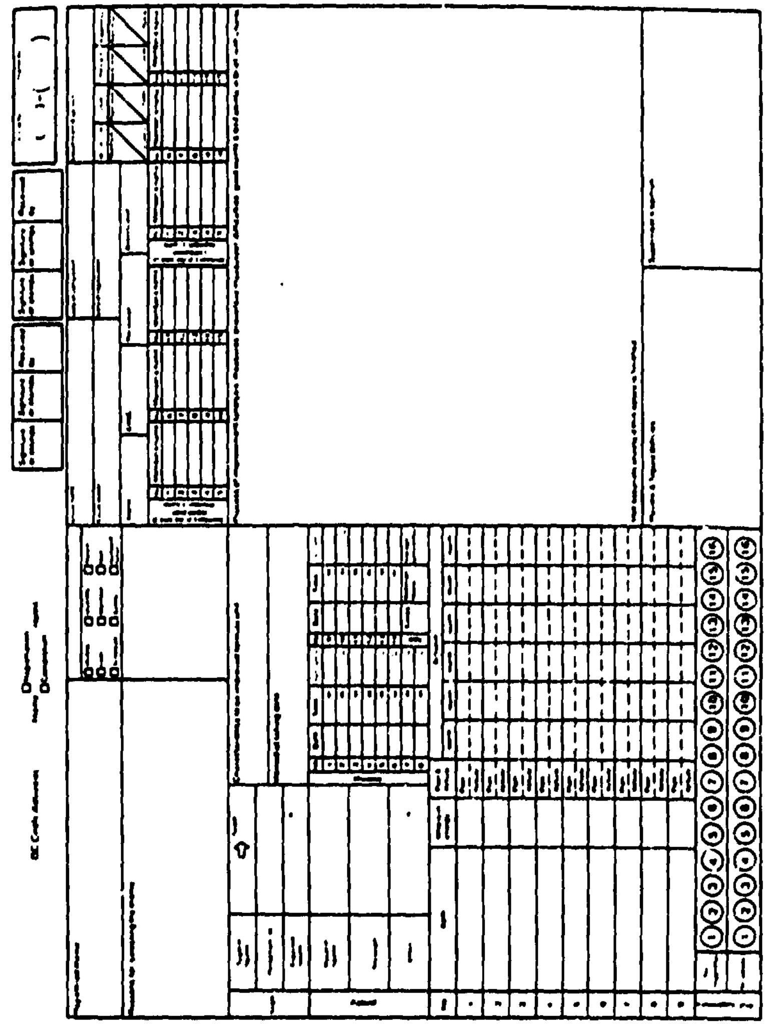


Fig.2.10 Example of Report of QC Circle Activities

3. Self-Evaluation of the QC Circle

3. .1 Self-evaluation and self-reflection

QC Circle members must review both the methods and results of their activities from time to time, self-evaluate and self-reflect their performance and correct mistakes if any.

QC Circle Activities cannot move on without checking the course. Most QC Circle need adjustment, checking against the original plan. There are two types of self-evaluation. One is the evaluation of each theme, and the other is of long-term activities.

(1) Theme self-evaluation

Every QC Circle must have a plan for activities. Each stage of the development of the circle should be compared with the plan, and progress evaluated.

One method of measuring progress is in terms of figures, for example, the number of improvements, percentage improvement of yield.

Another measure is methods and processes, for example, whether or not the study of cause and effect diagram has been completed. Whether the process of study was satisfactory.

Both the process and results of QC Circle Activities need checking against QC Circle Activity plan. Figure 3.10 (p.103) "QC Circle Activity Plan and Report" and Table 3.3 and Table 3.4 check list can be used as references.

(2) **Continuity; whether QC Circle Activities are continuously carried out, as an integral part of daily workshop operation.**

QC Circle Activities continue as long as the workshop exists. A QC Circle does not disintegrate or cease to function when one theme has been completed. Members tackle one theme after another. Active circles solve 2 to 4 problems (themes) per year on the average. Some of them solve more than 10.

QC Circles do not separate daily workshop operation. Everything that happens in the workshop is part of QC Circle Activities. Any time a problem is identified, all members get together, as QC Circle members should do, and study the problem applying the QC Circle approach. The themes of such a QC Circle are studied and solved, and daily operation is also handled by the circle. One foreman said to the writer that his workshop cannot do anything without the QC Circle.

QC Circle Activities are not "in addition to" daily workshop operation. So far as the members feel that they must do something extra called "QC Circle Activities", their activities have not yet matured.

The QC Circle Grand Prize was established to commend QC Circle which carry out their activities continuously and constantly.

Table 3. is a check list used to evaluate the level of activities from the standpoint of continuity and to what extent QC Circle Activities are integrated as a part of daily workshop operation.

Table 3.1 Self-check list of QC each theme (example)

<table>
<tr><th>ITEM</th><th colspan="3">CHECK POINT</th><th>MARK</th></tr>
<tr><td>1. theme selection (20 points)</td><td colspan="3">1) Did all circle members discuss thoroughly?
2) Did members understand the background and problems of the theme?
3) Was the effect valuable?</td><td>20
10
0</td></tr>
<tr><td>2. participation (20 points)</td><td colspan="3">1) Did circle members willingly participate?
2) Was the cooperation of relevant departments requested when necessary?
3) did relevant departments cooperate willingly?</td><td>20
10
0</td></tr>
<tr><td rowspan="6">3. procedure (40 points)</td><td>ITEM</td><td>CHECK POINT</td><td>MARK</td><td rowspan="6">40
30
20
10
0</td></tr>
<tr><td>1. achievement of the goal (10 points)</td><td>1) Was the goal achieved?
2) Was the goal adequate?</td><td>10
5
0</td></tr>
<tr><td>2. analysis (10 points)</td><td>1) Was the data sufficient?
2) Was the depth of analysis satisfactory?
3) Were QC methods effectively applied in the analysis?</td><td>10
5
0</td></tr>
<tr><td>3. QC Circle activities (5 points)</td><td>1) Was teamwork good?
2) Were the members cooperative?</td><td>5
3
0</td></tr>
<tr><td>4. confirmation (5 points)</td><td>1) Were all the results confirmed?
2) Was the problem clearly understood at the time of confirmation?</td><td>5
3
0</td></tr>
<tr><td>5. standardization (10 points)</td><td>• Was everything necessary done to establish control state?</td><td>10
5
0</td></tr>
<tr><td>4. application of techniques (10 points)</td><td colspan="3">1) Were the appropriate techniques applied at each step of the analysis?
2) Were QC and IE techniques effectively used?
3) Were there unique applications of techniques?</td><td>10
5
0</td></tr>
<tr><td>5. satisfaction of supervisors (10 points)</td><td colspan="3">1) does the supervisor recognize the effects?
2) Does he think the activities were satisfactory as QC Circle Activities?
3) Is he satisfied with the attitude and performance of the QC Circle leader?</td><td>10
5
0</td></tr>
</table>

Table 3. Self-evaluation check list of long-term activities (example)

ITEM	CHECK POINT	EVALUATION Good	Av.	Bad
1 workshop environment	(1) creating a bright workshop (2) upgrading engineering technology (3) improvement of defective ratio, yield and efficiency (4) improvement of attendance rate (reduction of absenteesm) (5) safety			
2. motivation of members	(1) Are members motivated to carry out QC Circle Activities? (2) Do members understand QC Circle Activities? (3) Do they make efforts to develop themselves? (4) problems-consciousness. Are they becoming more aware? (5) Is training sufficient?			
3. Administration of QC Circle Activities	(1) independent and voluntary? (2) leadership. Is it good? (3) cooperation and coordination among members. Good? (4) guidance of supervisors and staff. Appropriate? (5) studying a theme. On schedule?			
4. QC Circle meetings	(1) Are meetings held as planned? (2) Is there any absenteesm or late arrival? (3) Does everyone speak? (4) Does everyone cooperate during the procedure of a meeting? (5) Is everyone informed about and understands the conclusions of a meeting?			

ITEM	CHECK POINT	EVALUATION Good	Av.	Bad
5. selection of a theme	(1) Is it selected voluntarily? (2) Is it in conformity with the supervisor's policies? (3) Is it suited to the ability of members? (4) Is the goal clear? (5) Is it selected taking relations with other departments into considerion?			
6. plan and process of problem solution	(1) Is everyone involved in the process of making a plan? (2) Is the plan implementable? (3) Does everyone share a role? (4) Are techniques properly applied? (5) Is teamwork in problem solving good?			
7. confirmation of results and prevention of slip-off	(1) Was the plan followed? (2) Was the effect properly evaluated? (3) Were the improvement ideas understood and accepted by the people interested or affected? (4) Was the result of improvement standardized? (5) Are members well informed about changes and improvement?			
8. summary of the results	(1) Does the report summarize the process as a case history of Quality Control? (2) Is the result correctly evaluated? (3) Was the result reported to the supervisors? (4) Is there an opportunity for making presentations? (5) Is the opportunity for presentation given equally to all members?			
9. actions to take the next step	(1) Have the members become more confident and motivated? (2) Have the measures taken to arrest problems already been discussed and studied in the circle as a theme of the circle? (3) Have the problems of QC Circle operation and administration already been solved? (4) Is there any progress? (5) training of new recruits. Good?			

ITEM	CHECK POINT	EVALUATION		
		Good	Av.	Bad
10 review of the activities	(1) meeting schedule and time. Appropriate? (2) morning and evening routine meetings, time spent waiting for the next job. Are these short time periods effectively used? (3) reports of Conferences and meetings inside and outside of one's own company, and reports of other QC Circle events. Have the participants reported? (4) Are the members informed of QC Circle Activities in other related departments? (5) Are there many suggestions submitted?			
What do you think was the best for you during this period?	total (A) multiplier			
What do you want to ask supervisors and staff?	total (B) grand total			

How to use this check list.

1. *A leader fills this list in asking members opinions and comments. The check list is used by the leader to review the activities of his QC Circle.*
2. *All the check points should be checked frequently. The list is summerized twice a year (bi-annually) for submission to and comment by immediate supervisors.*
3. *Marks and evaluation*
   - *(1) Enter a circle mark to one of the three columns as appropriate.*
   - *(2) Total the number of circles in total (A).*
   - *(3) Calculate (A) multiplied and enter the product to total (B).*
   - *(4) Total the figures in (B) in the grand total box. The grand total ranges between zero and 100 with the average mark of 50.*

Appendix 1.

[redacted] Examples of themes and number of members of QC Circles in the indirect departments

M: Men W: Women

Department	Theme	M	W
administrative dept.	1. improvement of secretarial work	2	4
	2. standardization of serving meals to guests		3
	3. simplification of receptionist service	2	3
	4. time reduction of telephone switching and receiving of guest	1	5
	5. reduction of mail distribution errors	5	2
	6. improvement of receiving factory visitors	4	2
	7. reduction of typing errors and improvement of delivery		7
	8. reduction of telephone charges		2
	9. improvement of the check method of goods		5
	10. improvament of checking fire extinguishers	10	
personnel dept.	1. revision of attendance report	6	
	2. simplification of personnel roport forms	3	3
	3. reduction of wage calculation time	3	3
	4. elimination of calculation errors	3	3
	5. reduction of cancellation of duplicate copy of insurance policies		8
	6. improvement of safety statistics	3	1
	7. reduction of corrections to attendance records	1	3
	8. house keeping	5	2
	9. health consultation in the workshop and office	3	3
	10. improvement of company shop service		4
accounting dept.	1. improvement of budget planning	4	3
	2. improvement of financing and accounting jobs in sales departments	4	3
	3. standardization of accounting jobs	1	6
	4. simplification of cost estimation	8	
	5. quick retrieval of necessary forms and documents	3	3
	6. reduction of input output errors	4	2
	7. strict observance of delivery time of financial reports	3	3
	8. measures to cope with concentration of clerical work load	1	2
	9. reduction of payment slip issuance errors		8
	10. saving on office supplies	1	3

Department	Theme	M	W
production engineering & maintenance dept.	1. simplification of drawing & designing	11	
	2. accelerating the flow of drawings	8	
	3 study of engineering technology	13	
	4. preventive maintenance of cranes	10	
	5. improvement of instrumentation maintenance	7	
	6 standardization of cutting tools	5	
	7 reduction of electric charges	7	
	8. better control of spare tools	11	
	9 reduction in failures of critical machines	7	
	10 reduction of repair time	5	
tooling, warehousing & transportation dept.	1. transfer to a new warehouse	7	
	2. rationalization of transportation by reducing manpower	17	11
	3. reduction of stock level	3	
	4 improvement of transportation in bad weather	8	
	5 rationalization by charging packaging	9	
	6 improvement of inventory taking	6	
	7 improvement of storing methods	7	
	8. improvement of calculating and paying car freight charges	10	
	9. prevention of damages in "to be shipped goods"		
	10. acceleration of work slip issuance		
materials & purchasing dept	1. rationalization of order sheet preparation	3	3
	2. use of women workers in purchasing as a result of a plan to save indirect costs	2	3
	3 cost reduction of auxiliary materials	1	2
	4. efficient purchasing arrangement for experimental and pilot products	8	
	5. elimination of ordering errors	2	5
	6. possibility of changing standard meterials and components	5	1
	7 acceleration of monthly total reporting	4	3
	8 effective use of materials of no immediate use or need	13	
	9 review of filing system	6	
	10 simplification of telephone calls	11	11

Department	Theme	M	W
inspection & testing dept.	1 improvement of inspection equipment	8	
	2. improvement of measurement data feedback	3	
	3. improvement of material testing	14	
	4. reduction of inspection period	13	
	5. improvement in preparation of test pieces	12	
	6. elimination of inspection errors	8	
	7. efficient calibration of jigs, tools & instrumentation	4	
	8. house keeping of inspection and test tools cabins and rooms	7	5
	9. reduction of measuring time	7	
	10. reduction of errors in filling in test sheet	8	
engineering & designing dept.	1. reduction of design changes	9	
	2. improvement of engineering document control	3	5
	3. rationalization of parts drawing	6	
	4. reduction of drawing errors	4	
	5. better arrangement of catalogue original drawings	2	
	6. efficient clerical work	2	1
	7. strict deadline for experiments	3	
	8. elimination of green tea service by women staff members, elimination of time spent on cleaning and putting things in order by means of better house keeping	16	8
	9. efficient issuance of drawings	2	8
	10. elimination of copying errors		8
environment control dept.	1. improvement of cleaning inside of tar tanks	4	
	2. clean work environment	7	
	3. measures against odour from laboratory	7	
	4. improvement of waste acid treatment facilities	6	
	5. prevention of gas leakage through coke oven door	8	
	6. prevention of coal powder flying at the time of loading	7	
	7. stopping pollution at source	6	
	8. acceleration of checking oil content in waste water	5	
	9. prevention of failure of dust collectors	4	
	10. BOD (biological oxygen demand) control	6	

Department	Theme	M	W
safety dept.	1. rationalization of permission issuance for moving out goods	10	
	2. measures to reduce traffic congestion at shipping gates	7	
	3. rationalization of fire fighting service by means of better facilities and operation	8	
	4. prevention of vehicle accidents & formulation of traffic rules for vehicles and pedestrians	6	
	5. beautification of the main entrance and shipping gates	8	
	6. elimination of traffic accidents within company premises	9	
computer & other customer service depts.	1. improvement of customer service reporing	4	
	2. simplification of customer service procedure	7	
	3. better human relations	6	3
	4. better quality of customer service	6	2
	5. elimination of delivering wrong products by mistake	5	4
	6. reduction in operating time	8	
	7. reduction in operating errors	14	8
	8. reduction in key punching errors		8
	9. reduction in unnecessary outputs	3	1
	10. better utilization ratio of computers	7	1

I *INTRODUCTION OF QC CIRCLE*

I-1. *SCIENTIFIC MANAGEMENT*
(THE FREDERICK WINSLOW TAYLOR SYSTEM)

- 1. DEVELOP MANAGER'S JOB

  2. DIVIDE WORK INTO SMALLER ELEMENTS

  3. GET THE BEST WORKER FOR EACH JOB

  4. BE SURE FOREMAN OR MANAGER DOES

- MAKE PLANNING, DIRECTING AND CONTROLLING

  WORKERS DO *THE WORK AS GIVEN TO THEM*

I-3 *McGREGAR'S THEORY*

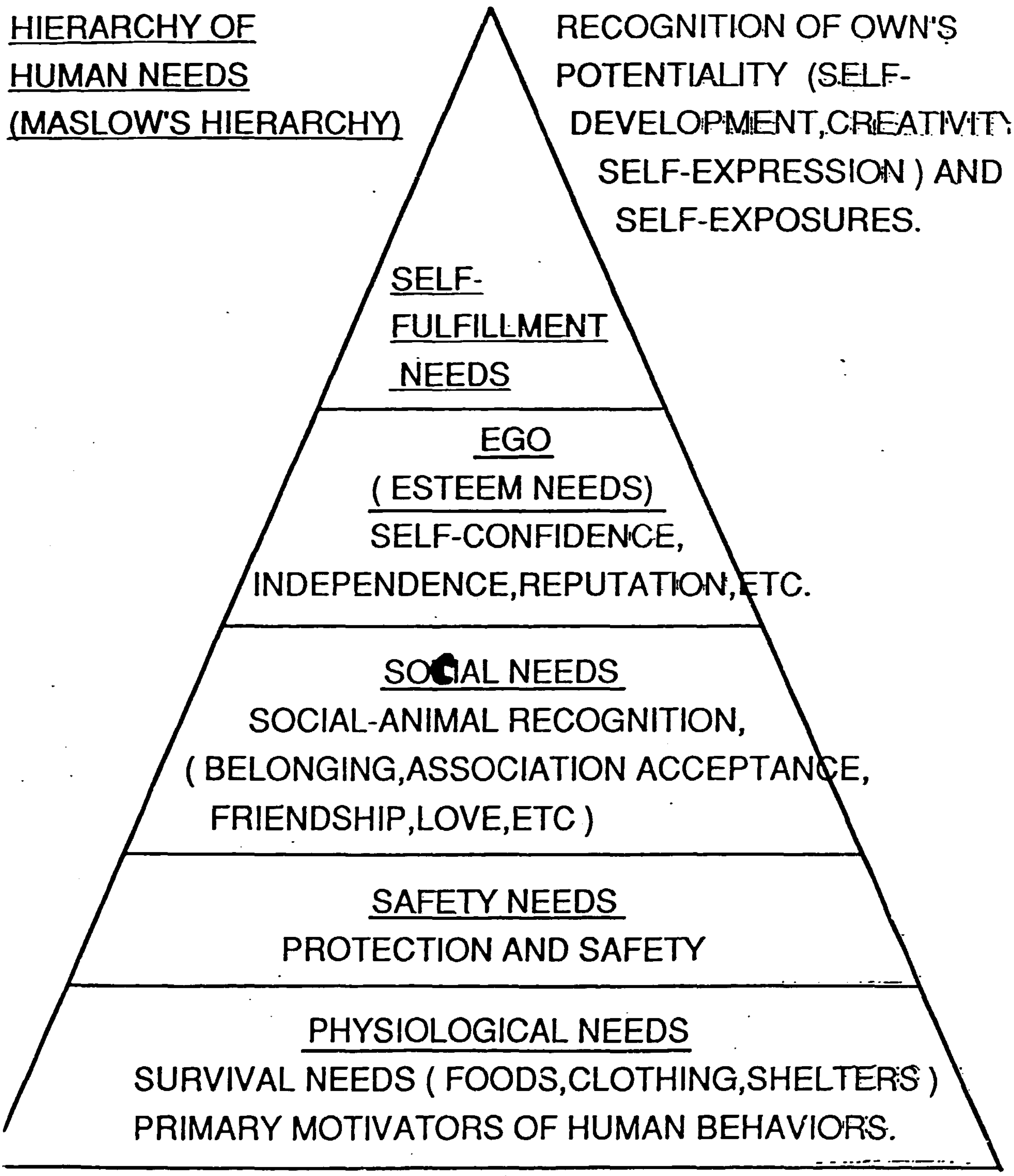
"X" ASSUMPTION

1. PEOPLE DISLIKE WORK
2. PEOPLE WISH TO AVOID RESPONSIBILITY, WANT SECURITY ABOVE ALL
3. PEOPLE MUST BE COERCED AND DIRECTED INTO PUTTING FOR THE EFFORT TOWARD THE ACHIEVEMENT OF ORGANIZATIONAL OBJECTIVES

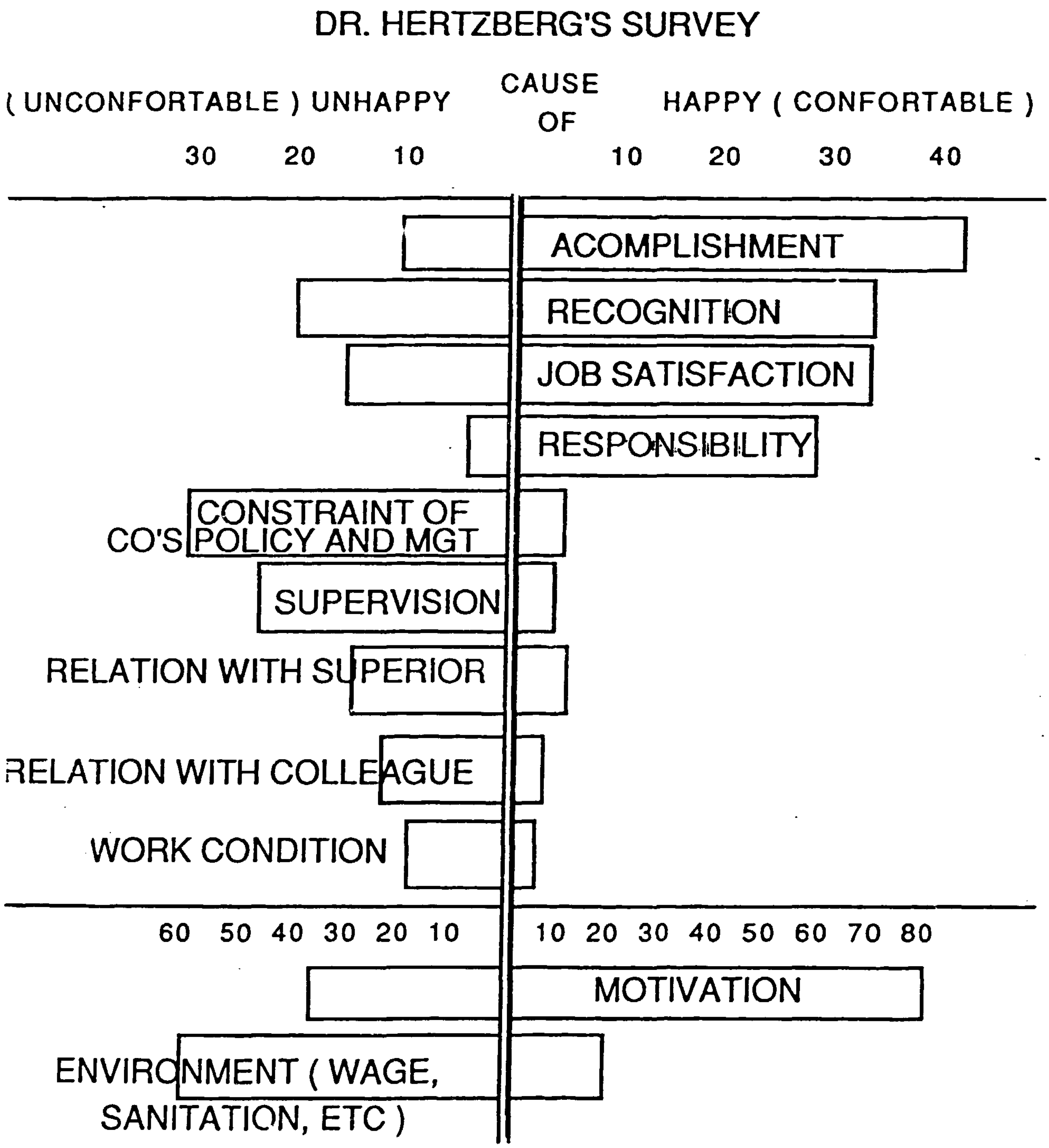
"Y" ASSUMPTION

1. THE EXPENDITURE OF PHYSICAL AND MENTAL EFFORT IS NATURAL. INADEQUATE CONTEXT, INDIVIDUALS DO NOT INHERENTLY ABHOR WORK.
2. EXTERNAL CONTROL IS NOT THE ONLY MEANS OF REGULATION OF WORK IN AN ORGANIZATION. BUT, SELF-CONTROL AND SELF-EDUCATION ARE ALSO AVAILABLE.
3. INDIVIDUAL ACCEPT AND INDEED SEEK RESPONSIBILITY AND WANT TO CONTRIBUTE

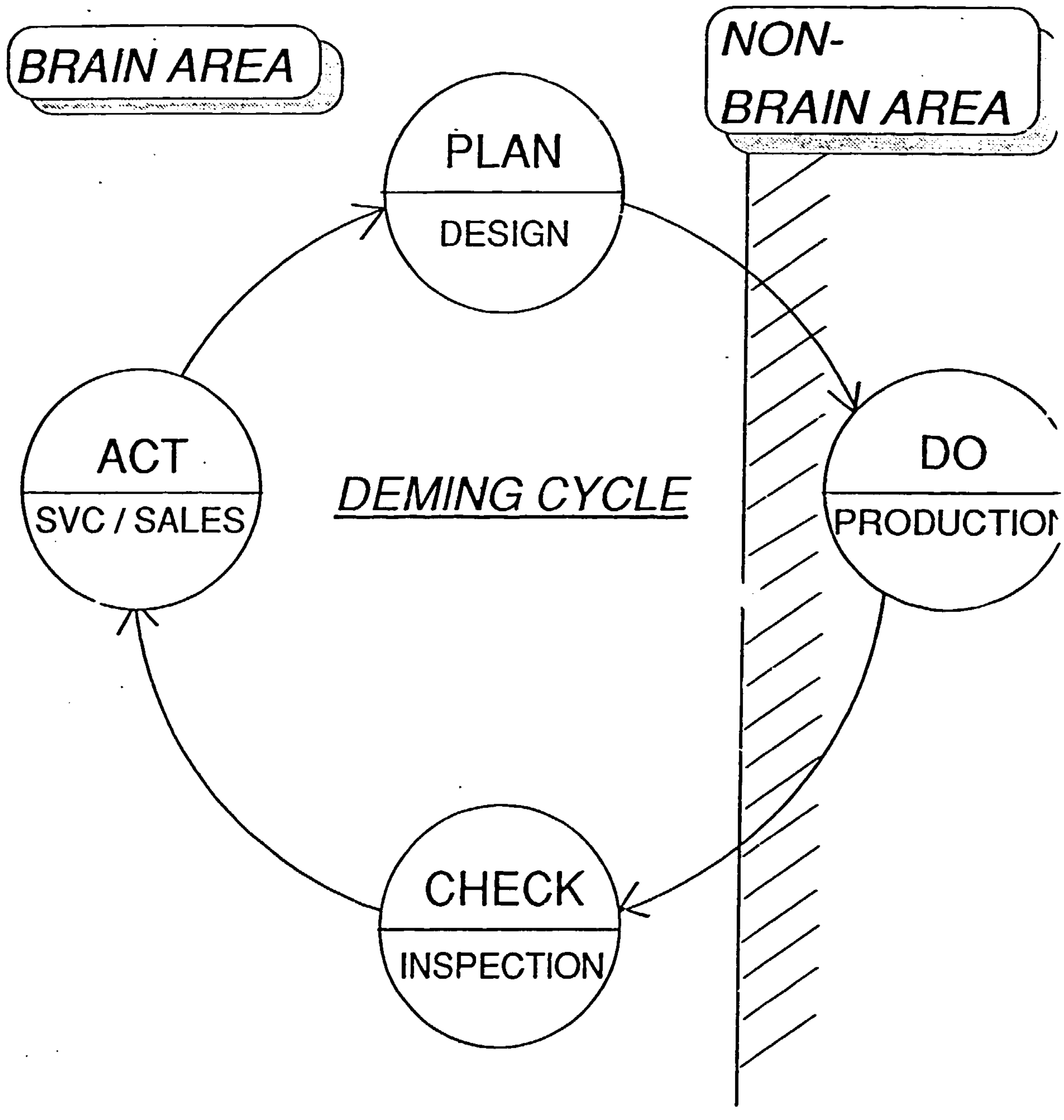
HIERARCHY OF HUMAN NEEDS (MASLOW'S HIERARCHY)



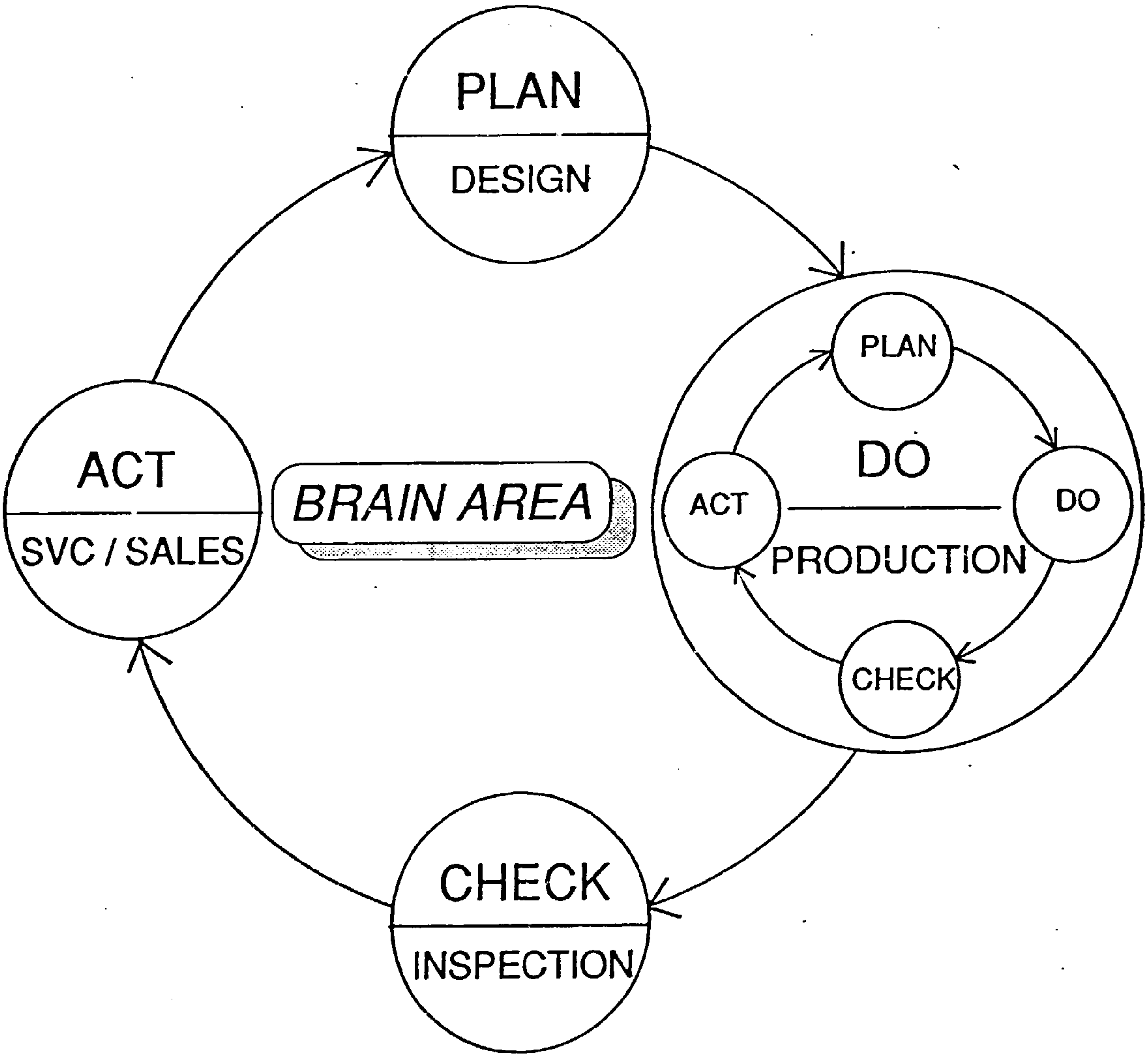
I-6 INTRODUCTION OF QC CIRCLE

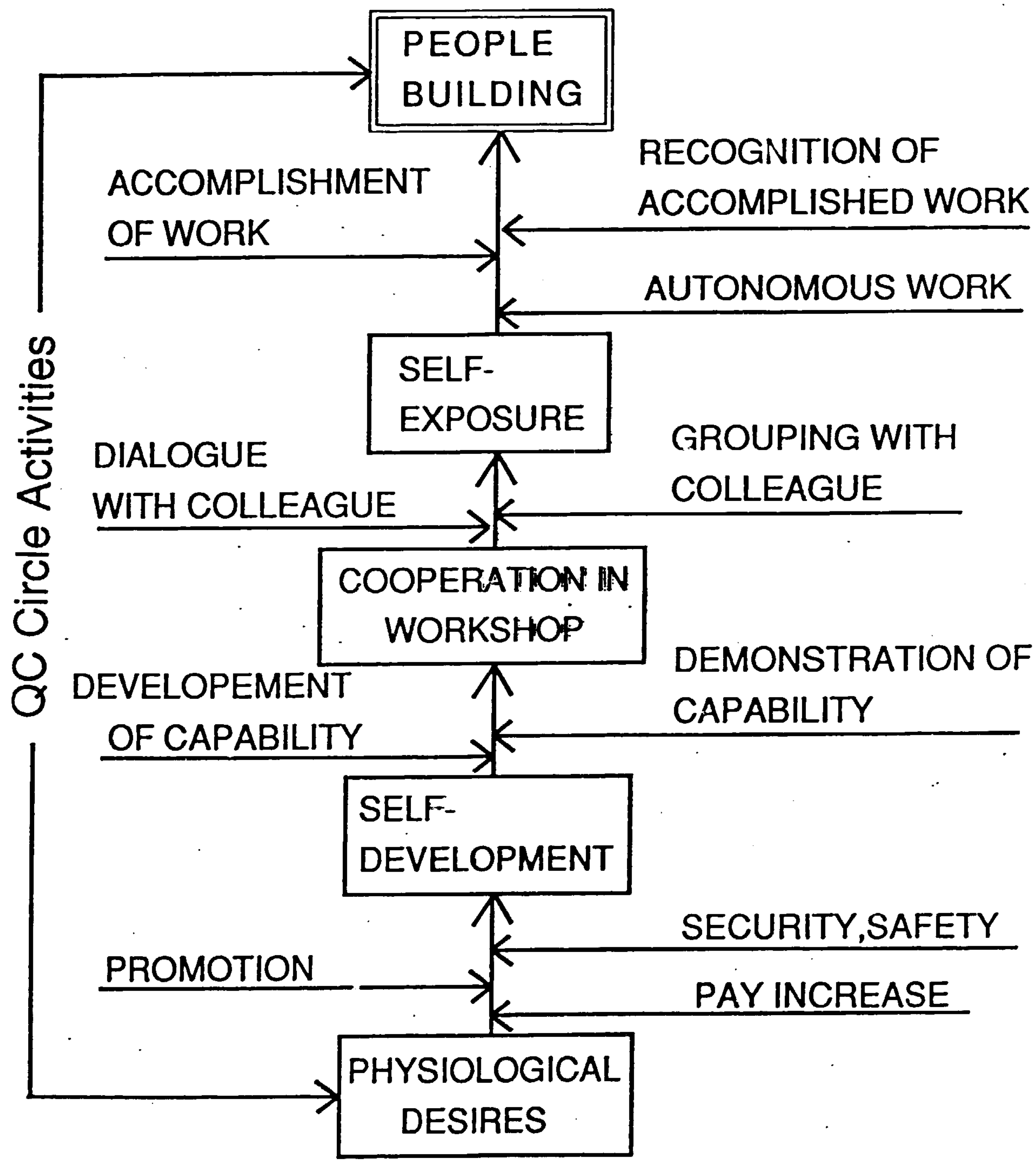


I - 7 The Relationship between the Deming Cycle (P-D-C-A Cycle) and the Taylor System

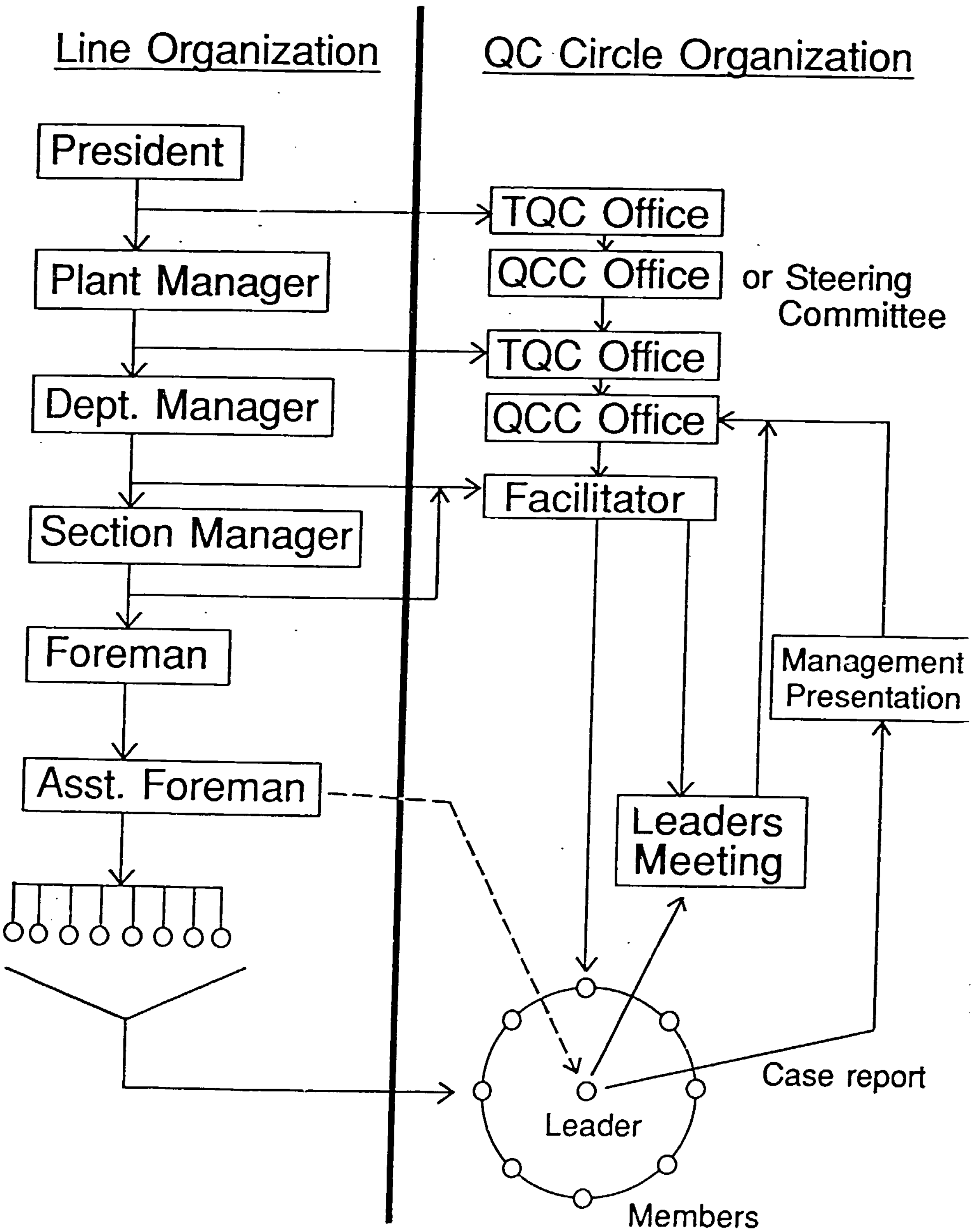


I - 8 *The P-D-C-A Cycle beyond the Taylor System*

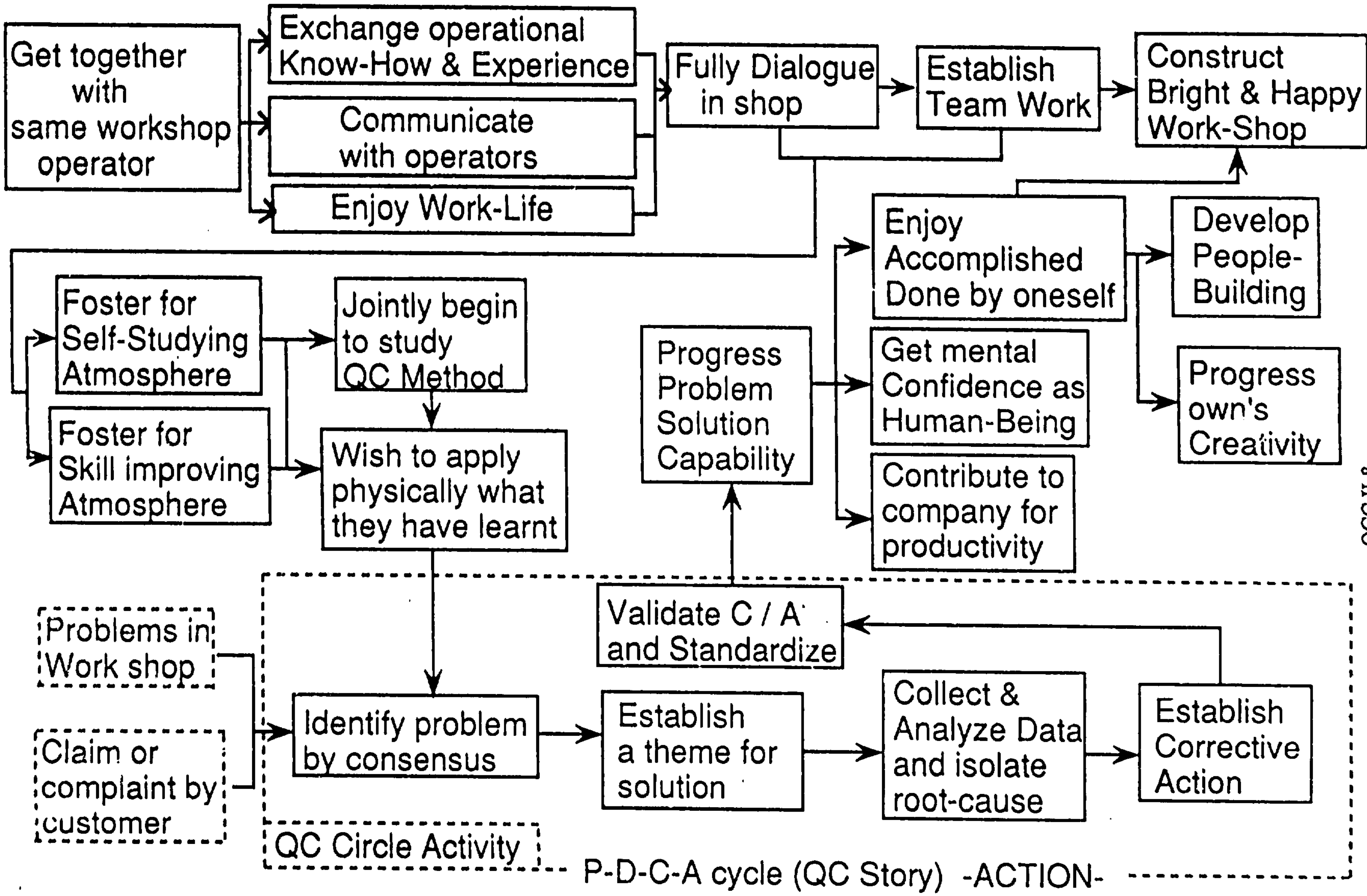



PEOPLE BUILDING
RECOGNITION OF ACCOMPLISHED WORK
ACCOMPLISHMENT OF WORK
AUTONOMOUS WORK
SELF-EXPOSURE
QC Circle Activities
DIALOGUE WITH COLLEAGUE
GROUPING WITH COLLEAGUE
COOPERATION IN WORKSHOP
DEVELOPEMENT OF CAPABILITY
DEMONSTRATION OF CAPABILITY
SELF-DEVELOPMENT
SECURITY,SAFETY
PROMOTION
PAY INCREASE
PHYSIOLOGICAL DESIRES

II-5 QC Circle Organization



QC Circle Activity Flow Chart



-QCC II-8-

TOTAL QUALITY CONTROL (SYNOPSIS)

JANUARY 1995

I. MIYAUCHI
COUNSELLOR
JUSE

SECTION

1. GENERAL

- DOING RIGHT THING
  [quality assurance and standardization]

- DOING THING RIGHT
  [continuous improvement]

T Q C $_{\text{JAPAN}}$

= (DR. DEMING)$^{\text{JAPAN}}$

(+)

(DR. JURAN)

(+)

(DR. FEIGENBAUM)

= (STATISTICAL)$^{\text{JAPAN}}$

(QUALITY CONTROL)

+

(QUALITY MANAGE-

(MENT)

+

(T Q C $_{\text{FEIGENBAUM}}$)

= COMPANY WIDE

QUALITY CONTROL

(C W Q C)

$$T.Q.C_{JAPAN} = (\text{TOTAL})^{JAPAN}$$

$$(\text{QUALITY})$$

$$(\text{CONTROL})$$

$$= \text{TOTAL}$$

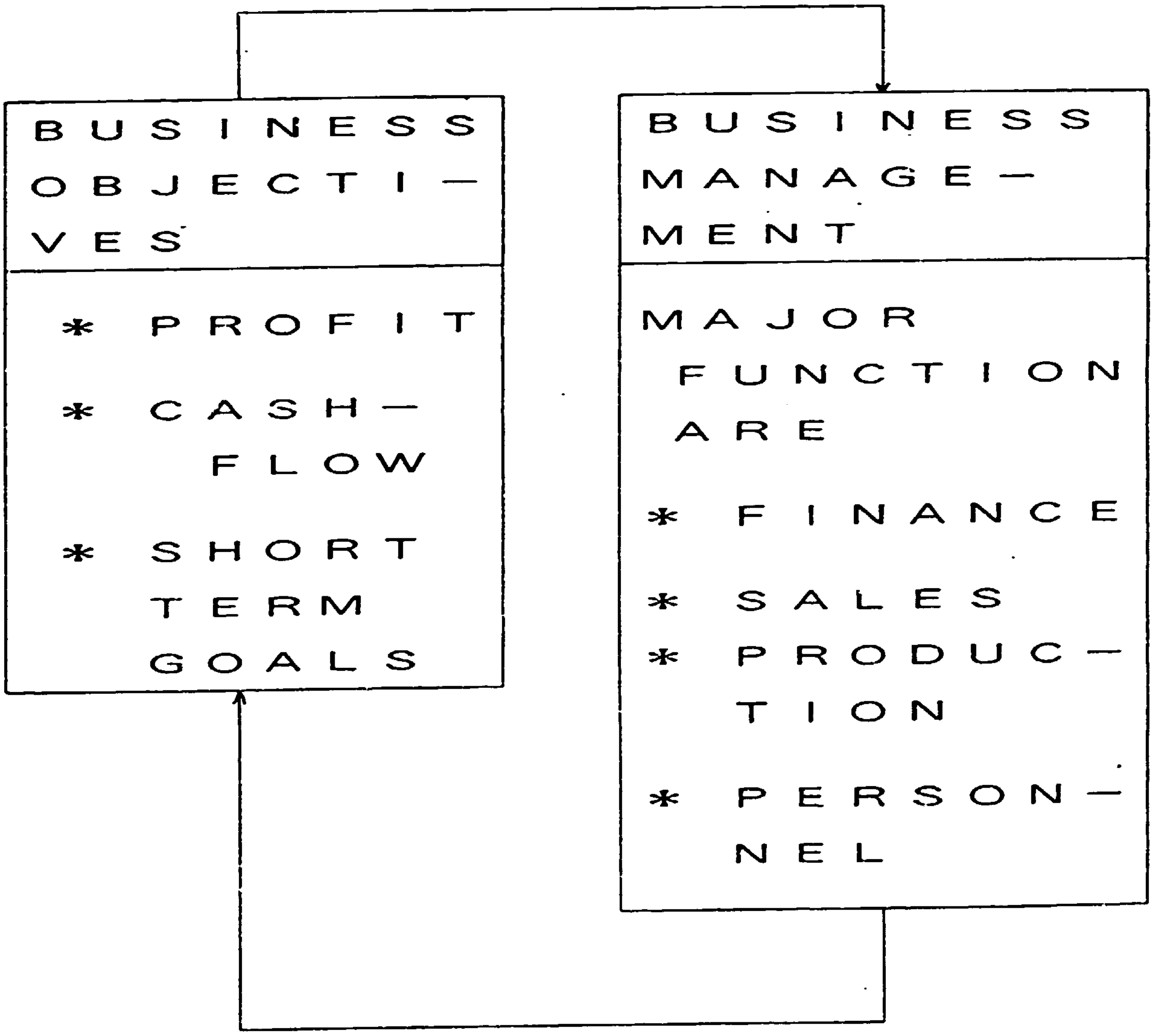
$$(\text{QUALITY} \times \text{CONTROL})$$

$$= \text{TOTAL QUALITY}$$

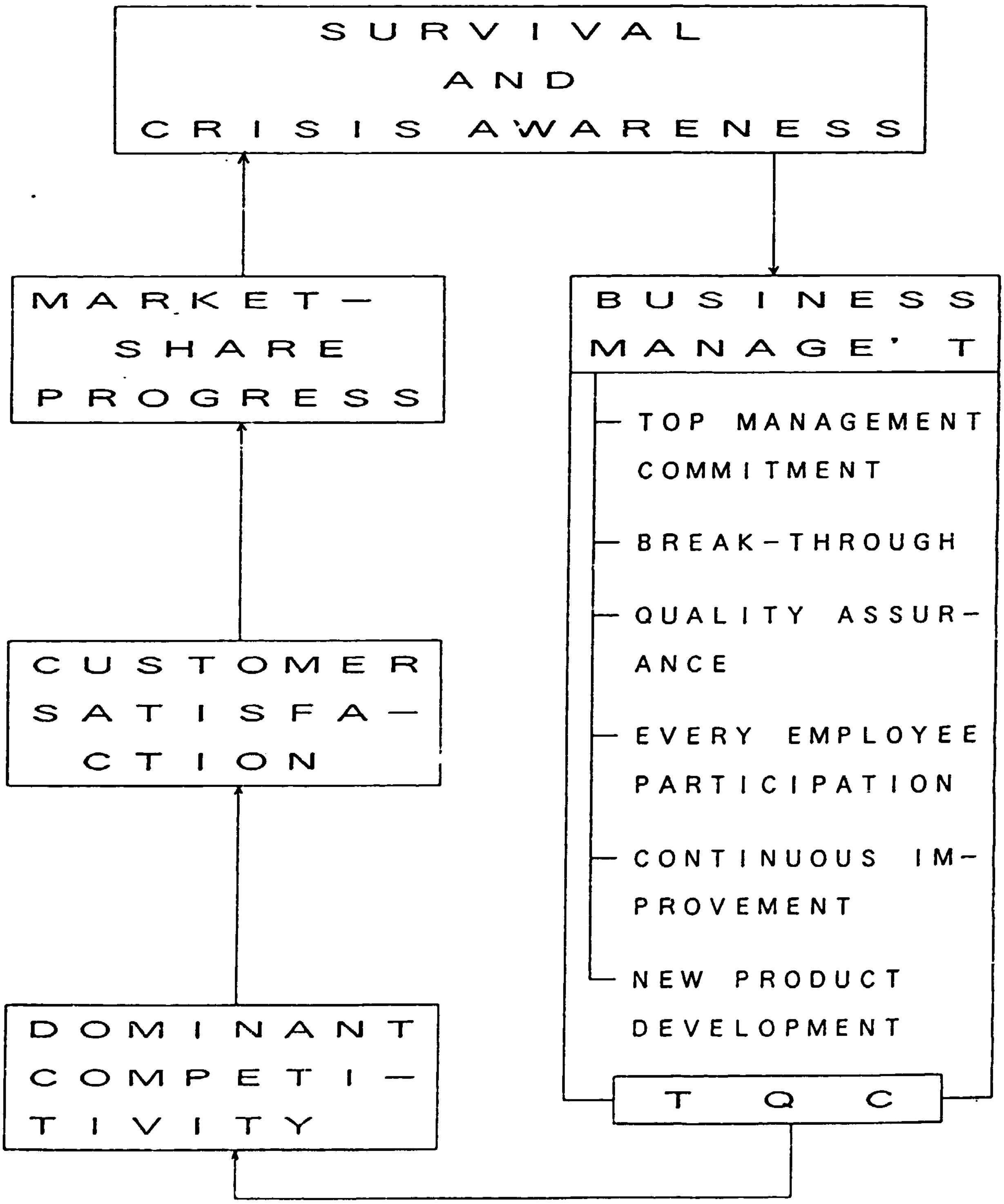
$$\times$$

$$\text{TOTAL CONTROL}$$

CONVENTIONAL BUSINESS MANAGEMENT



TQC CONCEPTED BUSINESS MANAGEM' T



TOTAL QULITY

: HARDWARE QUALITY

SOFTWARE QUALITY

PROCESS QUALITY

HUMAN BEHAVIOR

DAILY ROUTINE

WORK QUALITY

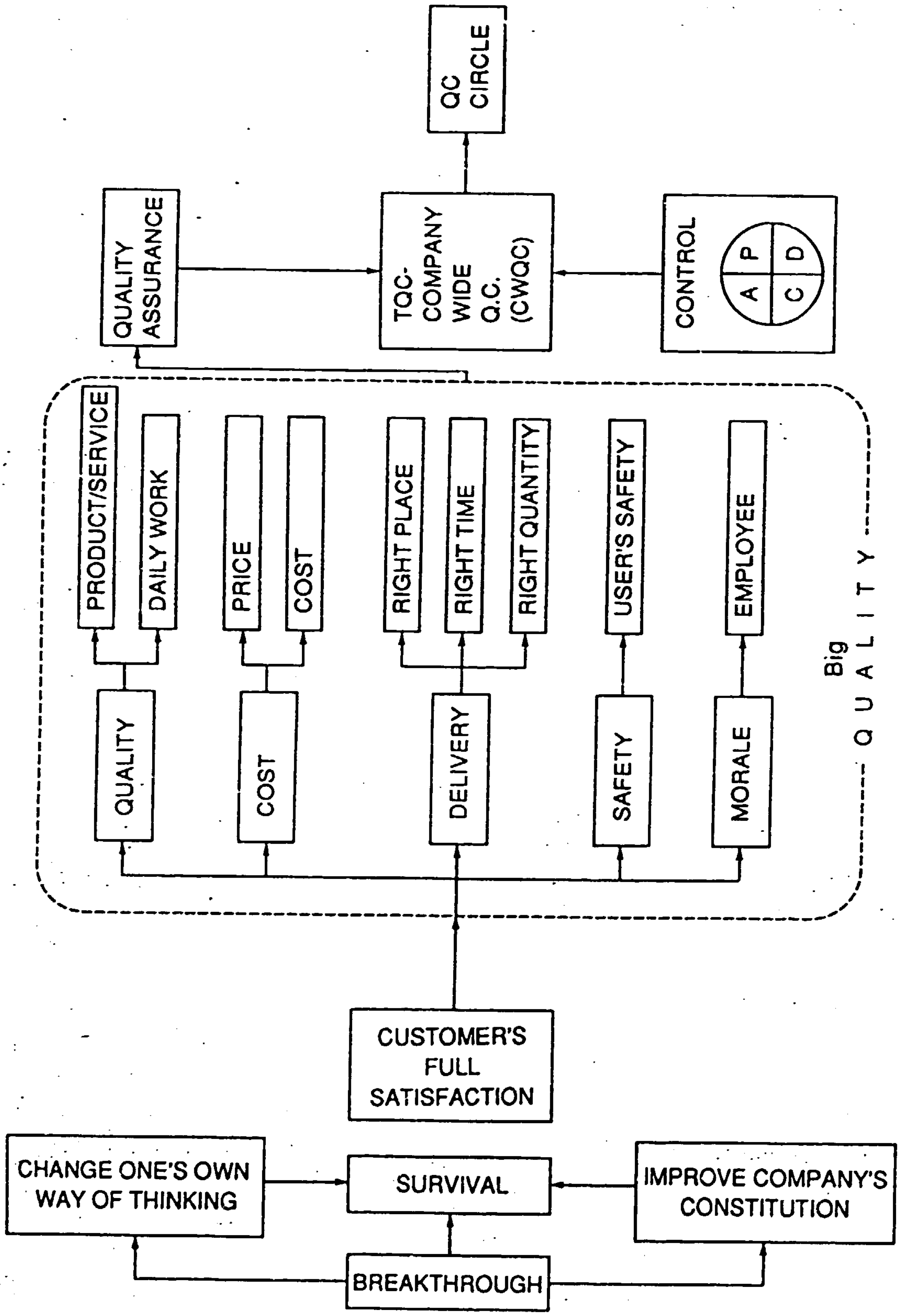
(ADMINISTRA-

TION, SEFVICE

FINANCE, PER-

SONNEL, CLER-

ICAL, ETC.)



QC CIRCLE
QUALITY ASSURANCE
TQC-COMPANY WIDE Q.C. (CWQC)
CONTROL
A
P
C
D
PRODUCT/SERVICE
DAILY WORK
PRICE
COST
RIGHT PLACE
RIGHT TIME
RIGHT QUANTITY
USER'S SAFETY
EMPLOYEE
QUALITY
COST
DELIVERY
SAFETY
MORALE
Big QUALITY
CUSTOMER'S FULL SATISFACTION
CHANGE ONE'S OWN WAY OF THINKING
SURVIVAL
IMPROVE COMPANY'S CONSTITUTION
BREAKTHROUGH

Big "QUALITY"

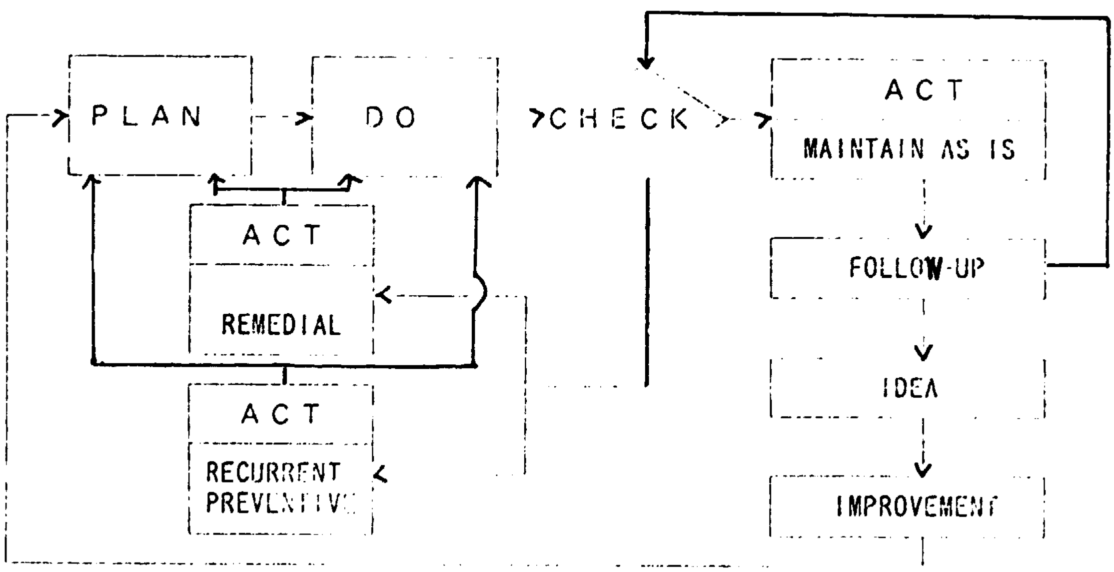
COMPANY - WIDE QUALITY

QUALITY	CHARACTERISTICS
TOP MANAGE-MENT	POLICY & OBJECTIVES DISSEM-INATION, SYSTEM & ORGANIZA-TION ESTABLISHMENT, PERSON ASSIGNMENT, INSTRUCTION, LEADERSHIP, COMMAND, HEALTH
COMPANY PERFOR-MANCE	PROFITABIL!TY, GROWTH RATE, DEVELOPABILITY, MARKET SHARE EXPANSION, COMPETITIVITY DO-MINANCY, NEW PRODUCT DEVELOP MENT, NEW TECHNOLOGY DEVELOP MENT,
PRODUCT/ SERVICE	PERFORMANCE, FUNCTION, RELI-ABILITY, MAINTENABILITY, SUS-TAINABILIT, SAFETY, EMPHATHY, TIMELINES, COURTEOUSNESS, CUSTOMER SATISFACTION CON-FORMANCE, CLAIM HANDLING
EMPLOYEES BEHAVIOR	MORALE AWARENESS, WORK-ETHIC SKILL LEVEL, EMPATHY & KIND-NESS AWARENESS, SPEAKING & WEARING MANNERS, PEOPLE-BUILD CONCEPT AWARENESS
WORK-SHOP ENVIRON-MENT	GOOD HOUSE-KEEPING STATUS, CLEANLINESS, HYGENIC STATUS, COMFORTABILITY, SAFETY ASSU-RANCE, GOOD MENU & DISHES, FREE-SPEAKING ATMOSPHERE
COMMUNITY CONTRIB'N	CULTURAL CONTRIBUTION, NON-POLLUTION PROBLEM (AIR, WATER ACOUSTIC, VIBRATION, ETC)
COMPANY IMAGE IN SOCIETY	ACCEPTANCE OF TOP MANAGEMENT BEHAVIOR, COMPANY'S REPUTA-TION, EMPLOYEES' REPUTATION, GENERAL ACCEPTANCE BY SOCIAL REPUTATION

TOTAL CONTROL

: PLAN - DO - CHECK - ACT

- : CONTINUOUS IMPROVEMENT AND MAINTAINING WITHOUT FAILURE

- 

QUALITY MANAGEMENT

DEFINITION:

THAT ASPECT OF THE OVERALL MANAGEMENT FUNCTION THAT DE-TERMINES AND IMPLE-MENTS THE QUALITY POLICY.

(BY ISO 8402)

SECTION

2. TQC - GENERAL

PARAGRAPH
2.1

DEFINITION OF TQC

TQC IS

AN ACTION

TO PRODUCE AND

DELIVER

COMMODITY OR

SERVICE

WHICH ARE CONFORM–

ING TO CUSTOMERS

NEEDS OR REQUIREM'T

BY BETTER
CHEAPER
FASTER
SAFER
EASIER

PROCESSING THAN

COMPETITORS

WITH PARTICIPATION

OF ALL EMPLOYEES BY

TOP MGT LEADERSHIP.

PARAGRAPH

2.2

TQC IMPLEMENTATION

BASIC STRUCTURE;

1. TOP MANAGEMENT COMMITMENT FOR ;

   - SURVIVAL CONCEPT
   - CUSTOMER SATIS-FACTION
   - DOMINANT COMPET-ITIVITY

2. VISION & STRATE-GY DISSEMINATION

   - LONG TERM
   - MEDIUM TERM
   - ANNUAL

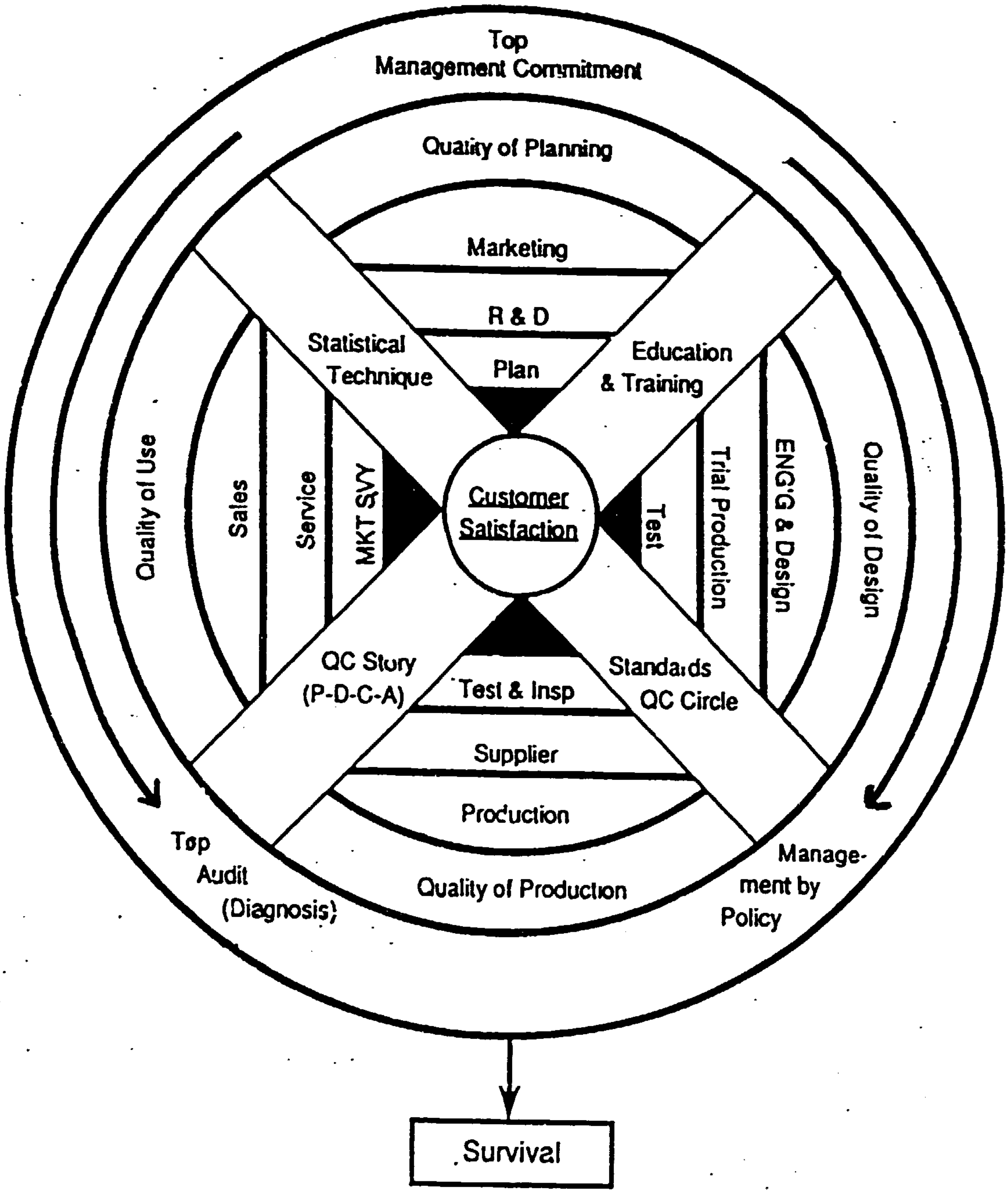
   POLICY AND OBJEC-TIVES

   WITH MEASUREABLE

   & VERIFIABLE ONES

3. STRUCTURE FOR:

- FUNCTIONAL ORGANIZATION
- AUTHORITY AND RESPONSIBILITY
- TQC STEERING COMMITTEE & OFFICE
- ASSIGNEMENT OF QUALIFIED PERSONNEL
- EDUACTION AND TRAINING PROGRAM FOR EVERY LEVELS


Top
Management Commitment
Quality of Planning
Marketing
R & D
Plan
Statistical
Technique
Education
& Training
Quality of Use
Sales
Service
MKT SVY
Customer
Satisfaction
Test
Trial Production
ENG'G & Design
Quality of Design
QC Story
(P-D-C-A)
Test & Insp
Standards
QC Circle
Supplier
Production
Top
Audit
(Diagnosis)
Quality of Production
Manage-
ment by
Policy
Survival

PARAGRAPH 2.3

TQC IMPLEMENTATION ACTIONS

1. PREPARATION OF STANDARDIZATION

2. EXECUT'N OF MANAGEMENT BY POLICY

   - CROSS-FUNCTIONAL MANAGEMENT (POLICY AND OBJECTIVE DEPLOYMENT)

   - DAILY ROUTINE-WORK MANAGEMENT (CONTINUOUS IMPROVEMENT AND SUSTENANCE)

3. QUALITY ASSURANCE

   - FOR EXTERNAL & INTERNAL CUSTOMERS (ESTABLISHMENT OF CONTROL AND CHECK ITEMS)

4. QULITY AUDIT BY TOP & SENIOR MANAGEMENT, QUALITY ASSUREANCE AND TQC OFFICES

5. USE OF STATISTICAL METHODS

6. EXECUTION OF EDUCATION AND TRAINING

7. INSTALLATION OF QC CIRCLE ACTIVITY

8. CONSULTATION BY TQC OFFICE FACILITATORS

PARAGRAPH 2.4

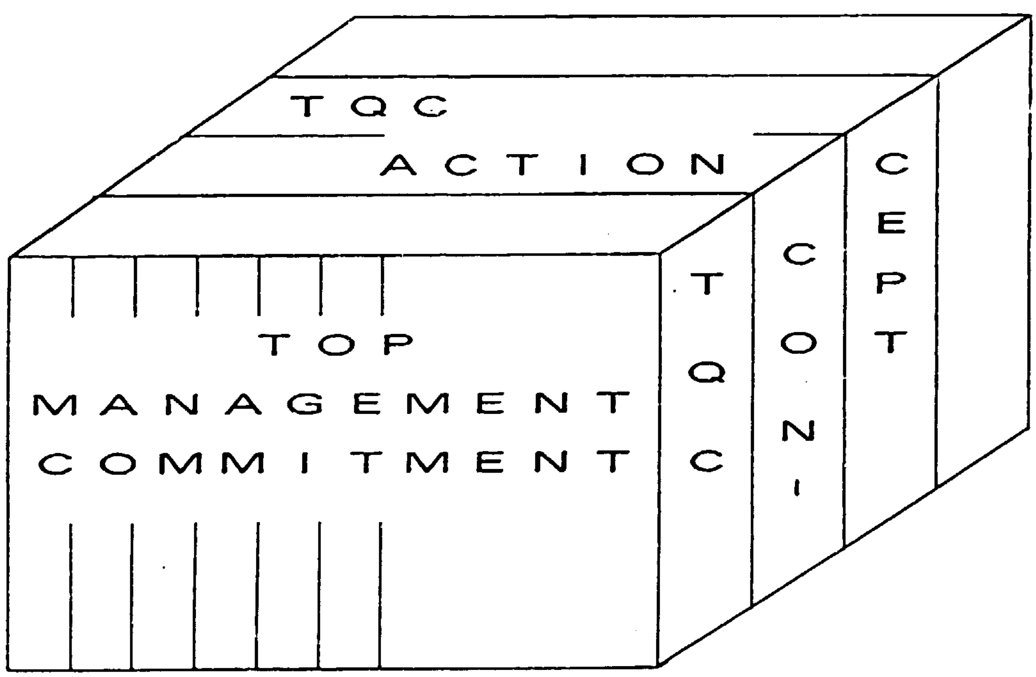
TQC CONCEPTS

1. "MARKET-IN" CONCEPT
2. NEXT DOWN STREAM SHOP IS CUSTOMER CONCEPT
3. "QUALITY FIRST" CONCEPT
4. UPPER STREAM PROCESS CONTROL CONCEPT
5. "FACT AND DATA" APPRECIATION CONCEPT
6. "VITAL FEW" CONCEPT
7. "DISPERSION CONTROL" CONCEPT
8. IN-PROCESS CONTROL CONCEPT

9. "RECURRENT FAILURE PREVENTIVE ACTION PRIORITY" CONCEPT

10. "PEOPLE BUILDING FIRST" CONCEPT

11. EMPLOYEES FULL PARTICIPATION OR INVOLVEMENT CONCEPT FOR TOP MANAGEMENT COMMITMENT



PARAGRAPH
2.4.1

<u>"MARKET-IN"</u> CONCEPT
(EMPATHY CONCEPT)

TO PRODUCE AND

TO SUPPLY

COMMODITY AND

SERVICES

WHICH ARE

DEFINITELY

REQUESTED BY

CUSTOMER.

<u>EMPATHY</u>:

TO TAKE ACTIONS

FOR ANY PERSONNEL

BY PUTTING YOURSELF

AT HIS POSITION OR

HIS CIRCUMSTANCES.

HOW TO DO
FOR "MARKET-IN"

1. TO INSTALL MARKET INFORMATION COLLECTING SYSTEM
2. TO IDENTIFY PRODUCT USE AND SERVICE ENVIRONMENT
3. TO MODERNIZE NEW PRODUCT & SERVICE DEVELOPMENTS
4. TO STRENGTHEN NEW TECHNOLOGY IMPLEMENTATION
5. TO PREVENT FROM ANY DEFECTS BY PREDICTING OR FORECASTING AT EARLIER PHASES

6. TO ESTABLISH FULL QUALITY ASSURANCE SYSTEM AND ORGANIZATION

7. TO PREPARE FOR A SMOOTH TRANSIT FROM PROTO-TYPE PRODUTION TO MASS STAGE

8. TO CONTINUOUSLY IMPROVE EVERY IN-PROCESSES AT PRODUCTION AND SERVICE STAGES UNDER CUSTOMER SATISFACTION CONCEPT.

9. TO SCIENTIFICALLY AND SYSTEMATICALLY SOLVE ANY PROBLEMS AT EVERY STAGES BY STATISTICAL ANALYSIS METHODS

10. TO ESTABLISH SERVISING NET-WORKS FOR CUSTOMER SATISFACTION

PARAGRAPH
2.4.2

"NEXT DOWN STREAM SHOP IS CUSTOMER" CONCEPT

TREAT YOUR DOWN-STREAM SHOP IS YOUR CUSTOMER WHO IS A KING OR QUEEN, THAT DON'T ARGUE WITH BUT FOLLOW WHATEVER THEY WANT IF ONLY IT IS REASONABLE

DON'T SEND ANY DE-FECTIVE OR WRONG PRODUCT OR SERVICE TO YOUR DOWN-STREAM SHOP

HOW TO IMPLEMENT "NEXT DOWN STREAM SHOP IS CUSTOMER" CONCEPT

1. TO IDENTIFY WHO IS YOUR CUSTOMER
2. TO STUDY WHAT KIND OF WORKS ARE OPERATING AT NEXT DOWN STREAM SHOP AND HOW YOUR QUALITY ARE CONTRIBUTING TO THEIR QUALITY INTEGRATION
3. TO CLARIFY WHICH QUALITY CHRACTERISTICS ARE IMPORTANT OR CRITICAL TO DOWN STREAM SHOP
4. TO ESTABLISH FIRM WRITTEN PROCEDURE TO ASSURE SUCH CUSTOMER REQUESTED QUALITY FOR DOWN STREAM SHOP

5. TO ESTABLISH FOR ELIMINATING OR IM-ROVING PROGRAM FOR ANY DETRIMENT-AL OPERATIONS IN OWN SHOP TO CUSTO—MER

6. TO ESTABLISH OWN'S DEFINITE CRITERIA FOR DECISION FOR YOUR CUSTOMER UNDER SELF—CON—ROLLING AWARENESS

7. TO CONDUCT SELF—INSPECTION FOR DOWN STREAM SHOP BY SELF—QULITY AWARENESS

PARAGRAPH
2.4.3

HOW TO IMPLEMENT "QUALITY FIRST"

1. TO IDENTIFY QUALITY WHICH ARE LOCATED AS HIDDEN, POSSIBLE, POTENTIAL OR REVEALED CUSTOMERS NEEDS OR REQUIREMENTS IN MARKETS
2. TO DEFINE QUALITY AT PLANNING STAGE WHERE IS PREDICTING OR FORECASTING FOR NEXT 5 -- 10 YEARS CUSTOMER REQUIREMENTS AND STILL FAR BETTER THAN COMPETITORS

3. TO DESIGN QUALITY AT DESIGN STAGE WHERE IS TRANS- LATING AND INTER- PRETTING THOSE CUSTOMERS NEEDS OR REQUIREMENTS INTO MATERIALIZ- ED AND PRODUCIBLE WRITTEN DOCUMENT- ATIONS CALLED AS SPECIFICATIONS AND DRAWINGS

4. TO ASSURE QUALITY AT EVERY PRODUCT- ION STAGES, WHERE ARE CONFORMING WITH SPECIFIC DO- CUMENTATIONS, SOP

5. TO ASSURE QUALITY AT USING STAGE, WHERE ARE SUPPLY-ING FEASIBLE AND UNDERSTANDABLE OPERATION MANUAL, AND MAINTENANCE & REPAIRING HAND BOOKS, TO FURNISH BETTER CUSTOMER AFTER-SERVICES THAN COMPETITORS, AND TO SWIFTLY, AND SATIFACTORILY RESPOND ANY CLAIM AND COMPLAINT BY CUSTOMERS WITH EMPATHY CONCEPT

PARAGRAPH
2.4.4

"UPPER STREAM CONTROL" CONCEPT

QUALITY OF CUSTOMER SATISFACTION ARE EXCLUSIVELY RELYING UPON UPPPER STREAM QUALITY DECISION SUCH AS MARKETING, PLANNING, R & D, AND ENGINEERING

90 % OF PRODUCT QUALITY ARE DETERMINED AT DESIGN PHASE, AND ONLY 10 % OF IT ARE RESPONSIBLE BY PRODUCTION, INSPECTION OR SERVICE

HOW TO IMPLEMENT "UPPER STREAM CONTROL" CONCEPT

1. TO ESTABLISH NEW PRODUCT DEVELOPMENT SYSTEM AND IT ITS QUALITY ASSURANCE SYSTEM WHICH ARE COVERING FROM MARKETING THROUGH ENGINEEERING TO SALES AND SERVICE ORGANIZATIONS

2. TO IDENTIFY CUSTOMERS NEEDS AND REQUIREMENT BY QUALITY DEPLOYMENT METHOD

3. TO ASSURE QUALITY AT EVERY STAGES OR PHASES BY RESPONSIBLE ORGANIZATIONS AND IF FOUND NOT ASSURED, NEVER SEND TO THE NEXT

5. TO FORECAST, PRE-
DICT, OR SIMULATE
ANY POSSIBLE, OR
POTENTIAL FAILURE
WHICH MIGHT BE OB-
SERVABLE AR SUC-
CEEDING STAGES,
AND
TO TAKE PREVEN-
TIVE ACTIONS AT
PLANNING, DESIGN,
PROTO-TYPE PRO-
DUCTION & TEST, OR
PRE-PRODUCTION
STAGES.

6. TO INVESTIGATE AND
AND ESTABLISH COR-
RECTIVE ACTION
WHEN SOME TROUBLE
BE HAPPENED AT
SUCCEEDING STAGES
FOR WHY NOT BE PRE-
DICTABLE OR FORE-
SEENABLE AT UPPER
STREAM QUALITY
ASSURANCE ACTIVI-
TIES

7. TO PREPARE FOR STANDARDS TO SUSTAIN CONSISTENT QUALITY BY SUCH AS REGULATIONS, TECHNICAL STANDARDS, FLOW CHARTS, CHECK SHEET, STANDARD OPERATION PROCEDURES, OFFICE INSTRUCTIONS, ETC

PARAGRAPH
2.4.5

"FACT & DATA APPRECIATION CONCEPT

TO SPEAK
TO CONSIDER AND
TO TAKE ACTION
WITH DATA BASED
ON FACT

DON'T ACCEPT ANY
REPORTS WITHOUT
JUSTIFYING DATA
OF FACT

DON'T SUBMIT ANY
REPORTS WITHOUT
JUSTIFYING DATA
OR FACT

IF IT IS, IT COULD BE FICTION.

HOW TO IMPLEMENT
"FACT AND DATA
APPRECIATION"
CONCEPT

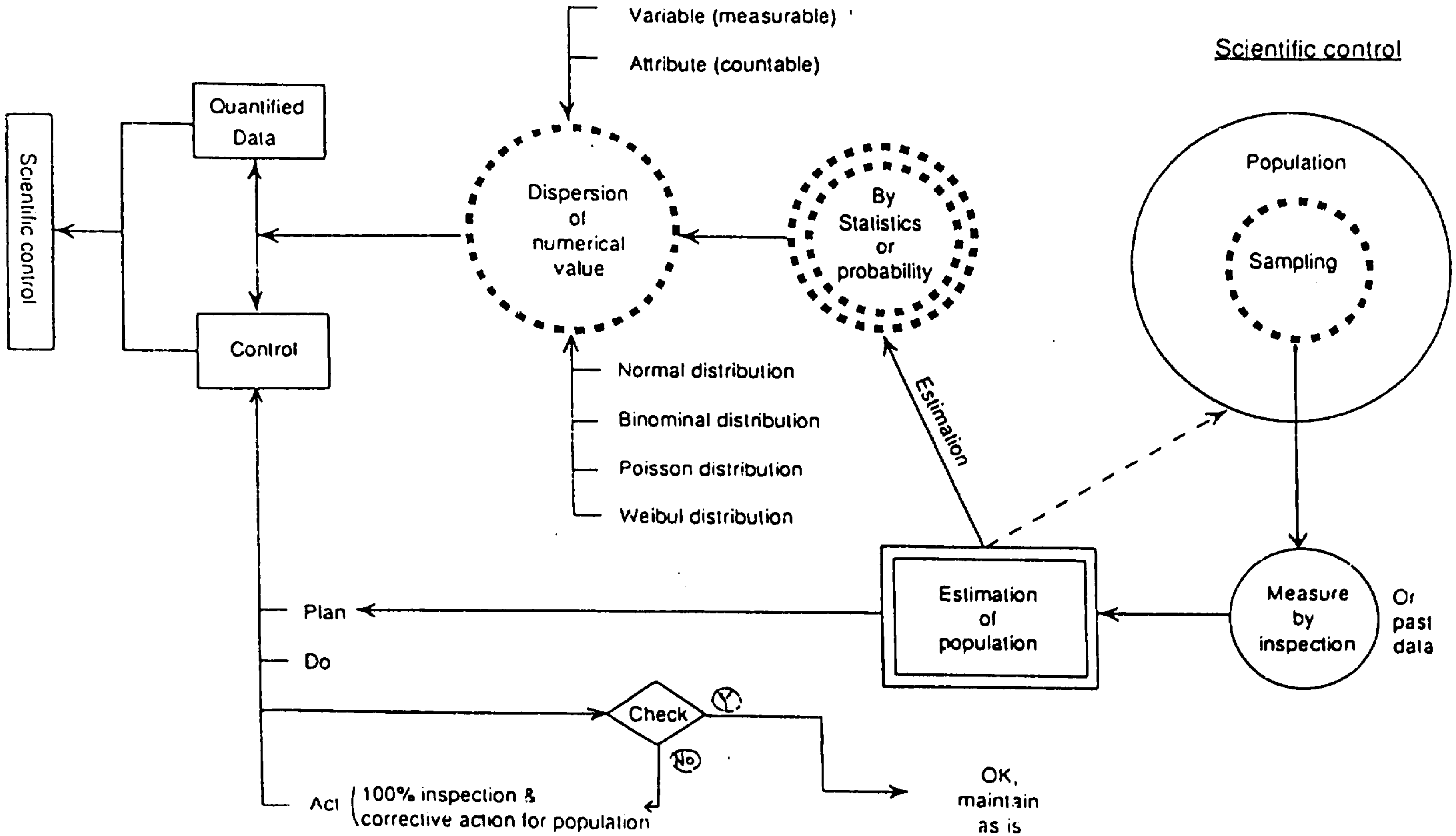
1. TO PHYSICALLY AND PERSONALLY VISIT A PROJECTING OR PROBLEM SOLVING SITE TO VERIFY OR OBSERVE FACT AND DATA COLLECTION

2. TO DETERMINE WHICH QUALITY CHARACTERISTICS ARE NECESSARY TO IMPROVE/ CORRECT AFTER STUDYING THEIR PRESENT STATUS

3. TO COLLECT DATA
AS SPECIFIED

4. TO ANALYZE DATA
COLLECTED
BY STATISTICAL
METHODS

5. TO SUMMARIZE AND
EVALUATE THE RE-
SULTS OBTAINED
AND PREPARE
REPORTS AS RELI-
ABLE AND RIGHT
INFORMATIONS
UNDER THOROUGH
CONSIDERATIONS



Scientific control
Variable (measurable)
Attribute (countable)
Quantified Data
Scientific control
Dispersion of numerical value
By Statistics or probability
Population
Sampling
Control
Normal distribution
Binominal distribution
Poisson distribution
Weibul distribution
Estimation
Estimation of population
Measure by inspection
Or past data
Plan
Do
Check
Y
No
Act (100% inspection & corrective action for population
OK, maintain as is

Data Source

PARAGRAPH 2.4.6

"VITAL FEW" CONCEPT

NOT TRIVIAL MANY,

BUT "VITAL FEW"

TO IDENTIFY THE MOST CRITICAL OR UNDESIRABLE PROBLEMS IN EVERY WORK-SHOPS AND TO SOLVE SUCH ONE WITH JUSTIFICATION AND STILL CONFORMING TO TOP MANAGEMENT COMMITMENT, WHICH ARE EXPLAINED BY FACT AND DATA UNDER THE HIGHEST PRIORITY

HOW TO IMPLEMENT "VITAL-FEW" CONCEPT

1. TO IDENTIFY OWN'S PRESENT STATUS AT WORKSHOP
   WHILE REVEALING WEAKNESS AND ST-RENGTH
   COMPARING WITH COMPETITORS
   BY SHAKE-DOWN WITH SUBORDINATES

2. TO ESTABLISH OWN BENCH MARKS FOR BETTERMENT
   ON THE SUBJECTS TO BE NECESSARY TO IMPROVE

3. TO PRIORITIZE THE CRITICAL OR UNDESIRABLE PROBLEMS ON PERFORMANCES, FUNCTIONS, RELIABILITY, SAFETY, PRICE, DEVELOPING DURATION, ETC., FIRSTLY, FOR REACHING THE BENCH MARKS ESTABLISHED, AND SECONDLY, FOR DEVELOPING TO MUCH BETTER OBJECTIVES THAN COMPETITORS ONES

4. TO DISCUSS AND CONFER WITH TOP OR SENIOR MANAGEMENT IF PROBLEMS IDENTIFIED ARE MEETING WITH THEIR POLICY AND OBJECTIVES

5. FINALIZE THE GOAL WITH QUANTIFIED INDEX AND PROGRAM TO BE FOLLOWED BY SPECIFIC DATE

PARAGRAPH
2.4.7

"DISPERSION CONTROL"
CONCEPT

ANY DATA HAVE TENDENCIES TO VARIATE OR DISPERSE

IT IS NECESSARY TO WATCH SUCH DATA DISPERSION CAREFULLY BY STATISTICAL METHODS, AND TO ANALYZE ITS ROOT-CAUSE ISOLATION FOR ESTABLISHMENT OF CORRECTIVE ACTION

HOW TO IMPLEMENT "DISPERSION CONTROL" CONCEPT

1. TO CAREFULLY INTERPRET AND EVALUATE FOR
   (A) <u>SHAPE OF DISTRIBUTION</u>
   (B) <u>AVERAGE VALUE OF DISTRIBUTION ($\bar{X}$)</u>
   (C) <u>VARIATION OF DISTRIBUTION (σ)</u>

2. TO STUDY AND IDENTIFY, WHY DISPERSION ARE HAPPENED IF CAUSED BY;
   (A) CHANCE CAUSE
   (B) ASSIGNEABLE CAUSE

3. IF IT IS CAUSED BY "CHANCE CAUSE", IT COULD BE DIS-REGARDED FOR FUR-THER ANALYSIS

4. IF CAUSED BY "ASSIGNEABLE", IT IS NECESSARY TO FURTHER ANA-LYZE FOR ISOLA-TION OF ROOT-CAUSE(S) TO ESTABLISH ANY CORRECTIVE ACTIONS FOR PREVENTION OF RECURRENT PROBLEM(S)

PARAGRAPH
2.4.8

" INPROCESS CONTROL "

CONCEPT

SO FAR ANY PRODUCT QUALITY ARE INTEGRATED INTO PRODUCT DURING EVERY INDIVIDUAL PROCESSING WORK THAT INSPECTION FOR FINISHED ONES ARE TOO LATE TO ASSURE ITS QUALITY.

AND

TOO LATE TO TAKE ANY CORRECTIVE ACTIONS.

ANY WORK MUST BE CONTROLLED

NOT BY RESULT

BUT BT INPROCESSES

HOW TO IMPLEMENT "INPROCESS CONTROL" CONCEPT

1. TO PREDICT ANY PROBABLE, POTENTIAL, OR HIDDEN PROBLEMS AT PRE- AND MASS PRODUCTION STAGES BY;

   A) QUALITY DEPLOYMENT (QUALITY FUNCTION DEPLOYMENT) METHOD

   B) FAILURE MODE EFFECT ANALYSIS METHOD

   C) FAULT TREE ANALYSIS METHOD

   D) HAZARD ANALYSIS METHOD

   E) DESIGN REVIEW BOARD SYSTEM

   F) PROCESS REVIEW BOARD SYSTEM

   G) SAFETY REVIEW BOARD SYSTEM (INCLUDED PRODUCT LIABILITY PREVENTION PROGRAM)

   BY DESIGN ENGINEERS

2. TO PREDICT PROBABABLE, POTENTIAL OR HIDDEN PROBLEM AT MASS PRODUCTION STAGE, BY;

A) QUALITY FUNCTION DEPLOYMENT METHOD

B) FAILURE MODE EFFECT ANALYSIS METHOD

C) QUALITY ASSURANCE SYSTEM FLOW CHART ANALYSIS METHOD

D) QUALITY CONTROL PROCESS CHART

BY PROCESS DESIGN ENGINEERS

3. TO STUDY, PREDICT OR FORECAST FOR FORESEENABLE USE OR MISUSE AND UNFORESEENABLE USE OR MISUSE AT CUSTOMERS USE-STAGE BY;

A) QUALITY DEPLOYMENT (QULITY FUNCTION DEPLOYMENT) METHOD

B) FAILURE MODE EFFECT ANALYSIS METHOD

C) FAULT TREE ANALYSIS METHOD

D) HAZARD ANALYSIS METHOD

E) DESIGN REVIEW BOARD SYSTEM

F) PROCESS REVIEW BOARD SYSTEM

G) SAFETY REVIEW BOARD SYSTEM (INCLUDED PRODUCT LIABILITY PREVENTION PROGRAM)

BY DESIGN ENGINEERS

4. TO EVALUATE DESIGN QUALITY ASSURANCE METHODS BY COMPARING WITH,

A) COMPETITORS STATUS FOR NEW OR CONVENTIONAL PRODUCTS

B) LITIGATED VERDICTS IN PRODUCT LIABILITY FOR SIMILAR PRODUCTS

C) CUSTOMER ACCEPTANCES FOR PAST CALIMS, OR COMPLAINTS HANDLINGS

5. TO EVALUATE PRODUCTION QUALITY ASSURANCE METHOD AND PRACTICES, BY COMPARING WITH ;

A) COMPETITORS STATUS FOR NEW OR CONVENTIONAL PRODUCTS AND PROCESSES

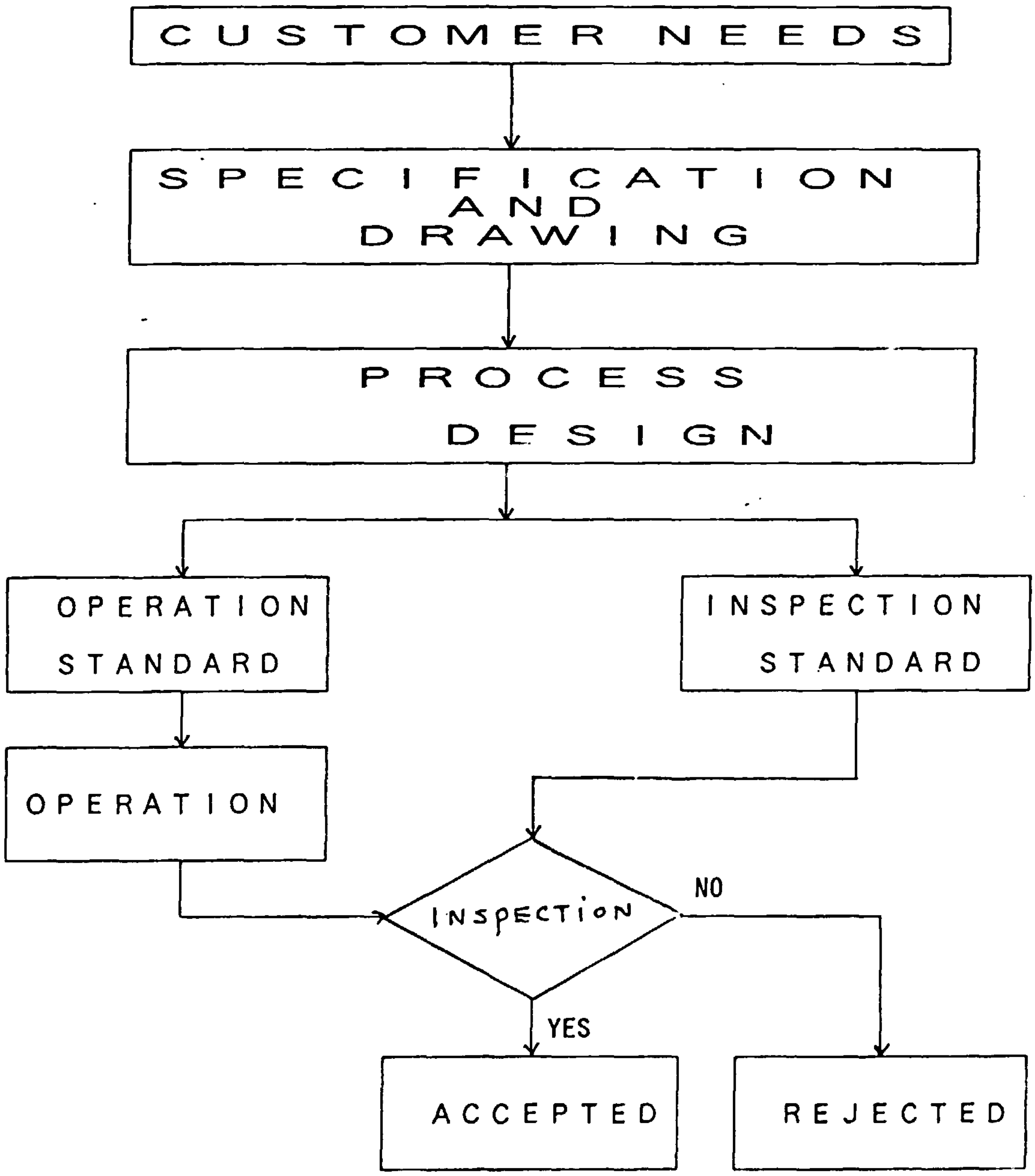
B) LITIGATED VERDICTS IN PRODUCT LIABILITY FOR SIMILAR PRODUCTS OR PROCESSES

C) CUSTOMER ACCEPTANCE FOR PAST CLAIM, OR COMPLAINT HANDLING

6. TO EVALUATE SERVICE QUALITY ASSURANCE SYSTEM AND PRACTICES BY COMPARING WITH ;

A) TO C) ACTIONS ARE NECESSARY TO FOLLOW AS SAME PROCEDURES AS EXPLAINED IN THE PRECEDING PARAGRAPH.

CONVENTIONAL "INSPECTION" CONCEPT



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PARAGRAPH 2.4.9

"REPETIVE MISHAPS PREVENTIVE ACTION" CONCEPT

DON'T MAKE ANY SAME MISTAKE

DON'T PERMIT SAME MISTAKE OR ERROR

TO ESTABLISH POSITIVE RECURRENT PREVENTIVE ACTION FOR NEVER HAPPENING AGAIN BY SAME CAUSE

HOW TO IMPLEMENT "REPETIVE MISHAP PREVENTIVE ACTION" CONCEPT

1. TO ESTABLISH SOP FOR EVERY INDIVIDUALS SPECIFIC WORKS
2. TO EDUCATE & TRAIN AND TO HAVE FAMILIAR WITH THEM
3. TO IMPOSE MORE ADDED-VALUE WORK TO EVERY INDIVIDUALS BY MANAGEMENT
4. TO DELEGATE WORKS AFTER CERTIFICATION AS POSSIBLE AS CAN DEPENDING ON THEIR CAPABILITY

5. TO ASK THEIR CREA-
TIVITY FOR SUSTE-
NANCE AND IMPROVE-
MENT OF THEIR DAI-
LY ROUTINE WORK

6. TO ESTABLISH EMP-
LOYEES CAREER DE-
VELOPMENT PROGRAM
UNDER PEOPLE-
BUILDING PHYLOSO-
PHY

"RESPECT EMPLOYEE AS HUMAN-BEING" CONCEPT

TO RESPECT EVERY EMPLOYEES AS INDEP-ENDENT HUMAN-BEING

- TREAT THEM AS PARTNER
- TREAT THEM WITH DIGNITY
- TREAT THEM AS ADULT
- TREAT THEM WITH RESPECT

PARAGRAPH
2.4.10

HOW TO IMPLEMENT "RESPECT EMPLOYEES AS HUMAN-BEING" CONCEPT

1. TO UNDERSTAND MR. A.H.MASLOW'S HIERARCHY PRINCIPLES AND Y-ASSUMPTION OF MR.D.MC'GREGOR

2. TO UNDERSTAND BEHAVIOR SCIENCE CONCEPTS
   - PROVIDE TASK VARIEY TO AVOID BOREDOM
   - ENLARGE THE JOB TO MEET THE SKILLS AND ABILITY OR WORKERS
   - PROVIDE FEED BACK ON PERFORMANCES
   - PROVIDE JOB CLOSURE OR JOB IENDIFICATION
   - SELF-CONTROL OF SIGNIFICANT ASPECT OF THE WORK
   - OPPORTUNITY TO LEARN NEW SKILLS
   - PARTICIPATION IN PROBLEM SOLVING, PLANNING AND CONTROLLING

3. TO ESTABLISH CA-
REER DEVELOPMENT
PROGRAM FOR EVERY
EMPLOYEES

4. TO DEVELOP FOR ED-
UCATION AND TRAIN-
ING SCHEME TO COM-
PLY WITH

5. TO MOTIVATE AND
CHALLENGE EMPLOY-
EES FOR FOSTERING
SELF-STUDYING AND
PARTICIPATING EN-
VIRONMENT AND CIR-
CUMSTANCE WITHIN
EVERY WORKSHOPS

6. TO ORGANIZE FOR
QC CIRCLE IMPLE-
MENTATION PROGRAM
BY FLOOR PEOPLE

7. TO IMPLEMENT EDU-
CATION AND TRAIN-
ING PROGRAM

8. TO HAVE THEM INST-
ALL QC CIRCLE AT
OWN WODKSHOPS

PARAGRAPH
2.4.11

"TOP MANAGEMENT COMMITMENT UNDERSTANDING" CONCEPT

TO FOLLOW THE TOP MANAGEMENT'S

- CREED, VISION STRATEGY AND MISSION STATEMENT BASED ON SURVIVAL DOMINANT COMPETI– TIVITY AND
- CUSTOMERS FULL SATISFACTIONS AND TO EXECUTE POLICY AND GOAL DEPLOYED BY THE TOP TO EVERY MANAGEMENT

HOW TO IMPLEMENT "TOP MANAGEMENT COMMITMENT UNDERSTANDING" CONCEPT

1. TO UNDERSTAND CO'S CREED
2. TO UNDERSTAND TOP MANAGEMENT VISION AND STRATEGY HOW TO PARTICIPATE AND SHARE WITH FOR ACHIEVEMENT
3. TO UNDERSTAND C0'S MISSION STATEMENT FOR SHARING WITH SOCIETY CONTRIBUTION RESPONSIBILITY
4. TO UNDERSTAND LONG AND MEDIUM TERM POLICY AND GOAL FOR PARTICIPATING WITH SURVIVAL AND COMPETITIVITY DOMINANCY

5. TO FOLLOW ANNUAL POLICY AND GOAL DEPLOYED BY THE TOP MANAGEMENT TO EVERY SUBORDINATE MANAGEMENT

6. TO IMPLEMENT FOR CONTINUOUS IMPRO-VEMENT AND SUSTE-NANCE ACTION AT OWN ASSIGNED ORG-ANIZATIONS UNDER TOP MANAGEMENT FIRM COMMITMENT FOR DOMINANT COM-PETITIVITY ESTA-BLISHMENT

7. TO ENCOURAGE SUB-ORDINATES FOR IN-STALLATION OF QC CIRCLE ACTIVITY WITHIN ORGANIZA-TION

8. TO CAHLLENGE AND MOTIVATE FOR PEO-PLE-BUILDING CON-CEPT IMPLEMENTING

SECTION 3

QC STORY (QC METHOD) FOR PROBLEM SOLUTION AND IMPROVEMENT

1. QC STORY (QC METHOD)

A QC STORY (QC METHOD) IS A SQUENTAL PROCEDURES FOR IMPLEMENTING OF CONTROL CONCEPT WHICH IS ORGANIZED BY CONTINUOUSLY REPEATING CYCLIC ACTION OF IMPROVING AND MAINTAINING FOR PROBLEM SOLUTION OR IMPROVEMENT ON DAILY ROUTINE WORK OR TOP MANAGEMENT COMMITMENT IMPLEMENTATION, AND IS TO FOLLOW CONTROL CYCLE WHICH IS ORGANIZED OF PLAN-DO-CHECK-ACT, AS SHOWN IN THE FOLLOWING STATED FIG. 1;

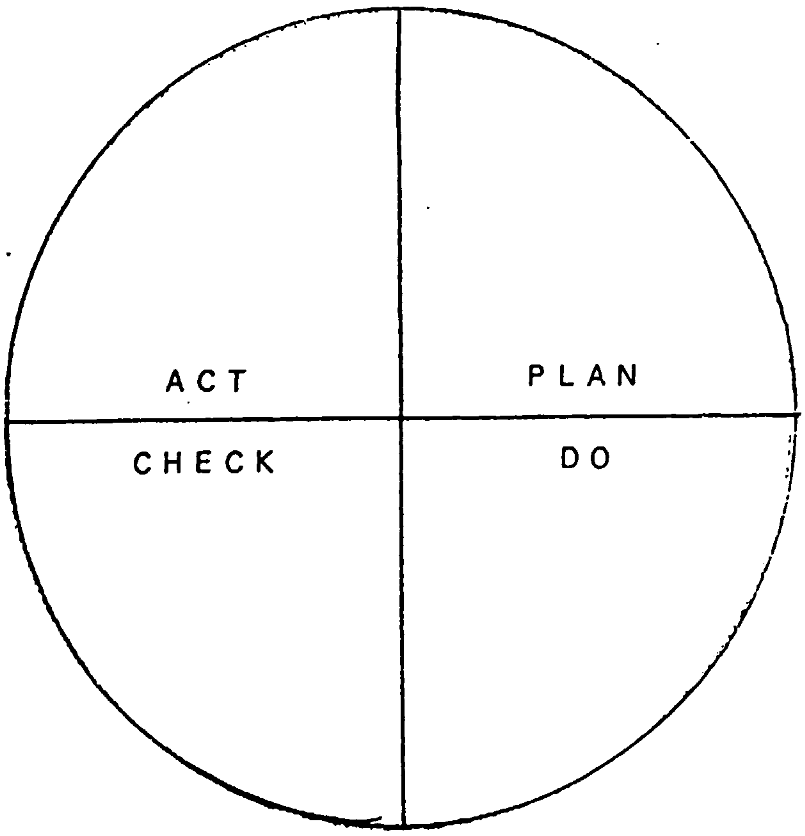


FIG. 1 CONTROL CYCLE

2. QC STORY (QC METHOD) SEQUENCES.

THE QC STORY (QC METHOD) IS ORGANIZED BY THE 8 STEPS AS SHOWN IN THE FOLLOWING SEQUENCES;

(1) IDENTIFICATION OF A PROBLEM FOR SOLUTION OR
A PROJECT FOR IMPROVEMENT.

(2) IDENTIFICATION OF A PRESENT STATUS (DATA COLLECTION) FOR
A PROBLEM OR A PROJECT.

(3) ANALYSIS OF DATA FOR ISOLATION OF ROOT-CAUSE (S)

(4) ESTABLISHMENT OF CORRECTIVE ACTION FOR ROOT-CAUSE(S)

(5) IMPLEMENTATION OF CORRECTIVE ACTIOM ESTABLISHED FOR SOLUTION OR IMPROVEMENT

(6) EVALUATION OF RESULT OBTAINED.

(7) ESTABLISHMENT OF STANDARD FOR SUSTAINING OF THE CORRECTED OR IMPROVED CONDITIONS

(8) INTROSPECTION OF THE WHOLE PROCEDURES TAKEN IF ANY RESIDUAL ACTIONS LEFT OVER AND IDENTIFICATION OF NEXT PROBLEM OR PROJECT IN FUTURE

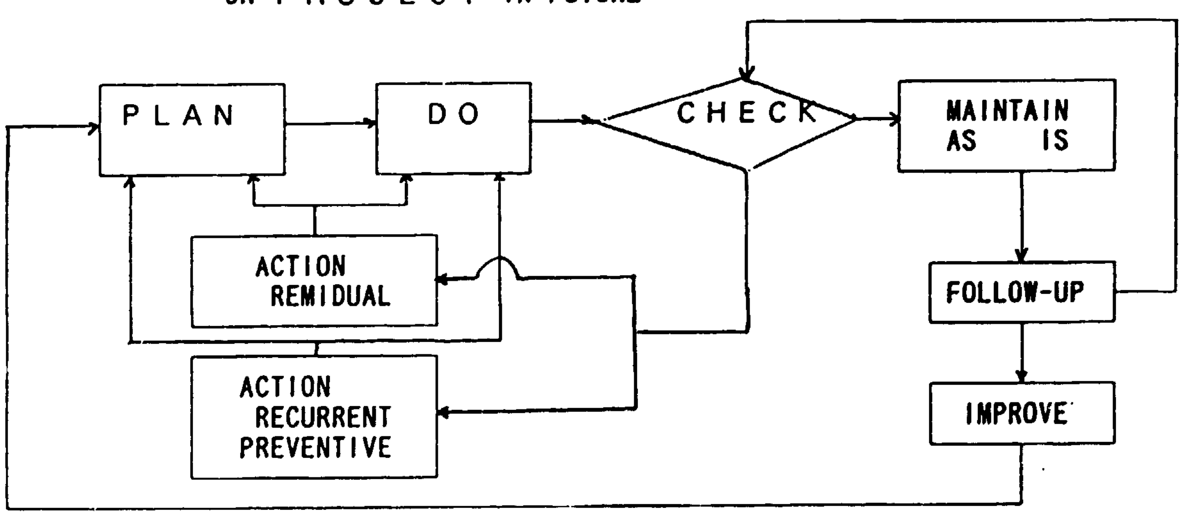


FIG. 2 CONTROL FLOW CHART

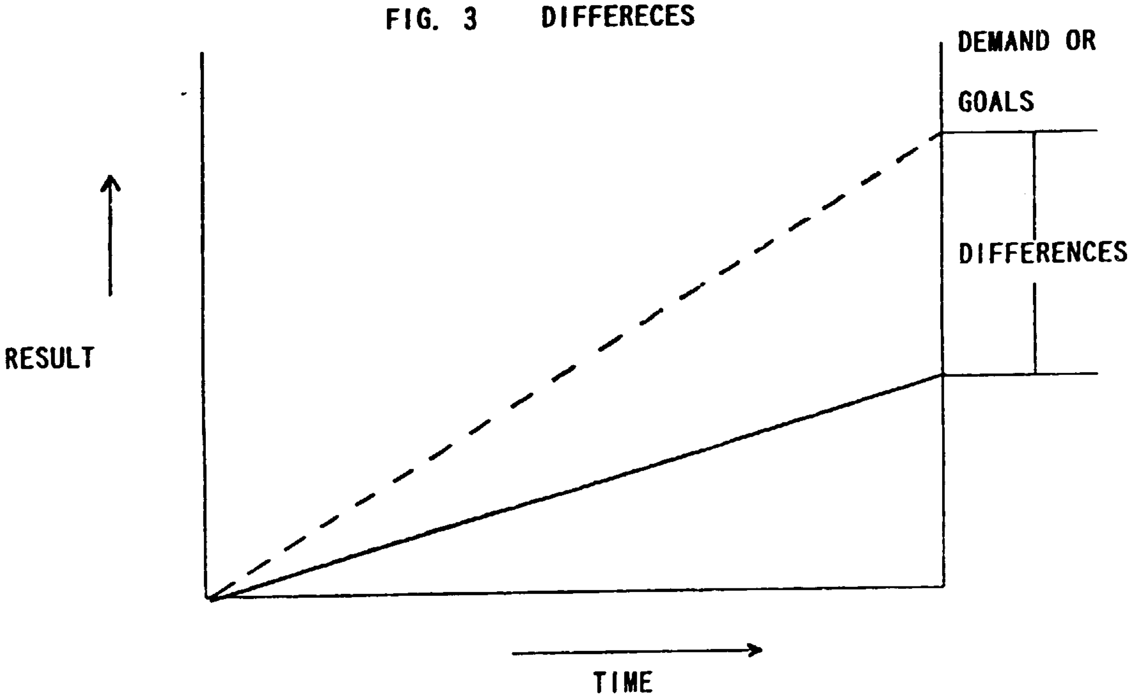
3 IDENTIFICATION OF A PROBLEM FOR SOLUTION
A PROJECT FOR IMPROVEMENT

3-1. IDENTIFICATION OF A PROBLEM OR PROJECT TO BE TACKLED.

(A) HOW TO IDENTIFY A PROBLEM OR A PROJECT AT FIRST HAND !

AS SHOWN IN FIG. 3 , THE DIFFERENCES BETWEEN CUSTOMERS DEMANDS/ REQUIREMENTS, OR GOALS ESTABLISHED AND PHYSICALLY OBTAINED OR RECOGNIZED FACT OR DATA IS TO BE CALLED AS ' P R O B L E M ' TO BE CORRECTED OR ' P R O J E C T ' TO BE IMPROVE AS REQUIRED.

FIG. 3 DIFFERECES



THE DIFFERENCES ARE SOMETIMES CALLED AS ' DEGREE OF UNDESIRABLE OR MISPLAYING SITUATIONS ' OR ' DEGREE OF UNSATISFACTORY STATUS TO CUSTOMERS 'THAT QC STORY (QC METHOD) IS NECESSARY TO IMPLEMENT FOR THEIR REMEDIES.

(B) AS SHOWN THE ABOVES, THE DIFFERENCES AS SUCH DEGREE OF UNDESIRABLE OR UNSATISFACTOY CONDITIONS MUST BE STATED BY A QUANTITATIVE NUMBER WHICH IS CALLED AS DATA OR FACT.

(C) HOW TO IDENTIFY PROBLEM OR PROJECT.

(1) FOR BEGINNER CIRCLE OR ORGANIZATION

BY BRAIN-STORMING METHODOLOGY, EVERY MEMBERS ARE NECESSARY TO SHAKE-DOWN OR DICUSSING FOR IDENTIFYING OF THEIR PROBLEMS OR WEAKNESS BASED ON THEIR EXPERIENCES, AS SUCH ;

--- ANY TROUBLES ENCOUNTERED DURING THEIR DAILY ROUTINE WORKS AT THEIR WORK SHOP.

--- ANY INCONVENIENT EXPERIENCES DURING THEIR DAILY ROUTINE WORK AT THEIR WORK SHOP.

--- ANY DIFFICULTIES ENCOUNTERED DURING THEIR DAILY ROUTIN. WORK AT THEIR WORK SHOP.

--- ANYTHING WELCOME OR ACCEPTABLE ACTIONS BY THE NEXT DOWN-SHOP TO ELIMINATE THEIR COMPLAINT, UNSATISFACTOY, OR UN-DESIRABLE HAPPENINGS, OR TO MEER WITH THEIR DEMANDS.

--- ANY CONTROLLABLE PROBLEMS OR PROJECTS WHICH ARE RATHER EASY TO ACCOMPLISH

(2) FOR ADVANCED OR EXPERIENCED CIRCLE OR ORGANIZATION

DURING THE SHAKE-DOWN PROCESSING, THROUGH THEIR BRAIN-STORMING, IT IS NECESSARY TO IDENTIFY ;

--- ANY CLAIM, COMPLAINT, AND/OR UNSATISFACTOY MATTERS REVEALED AT CUSTOMERS HANDS

--- ANY CLAIM, COMPLAINT, AND/OR UNSATISFCTOY MATTERS INFORMED BY DOWN-STREAM SHOPS

--- ANY DIFFICULTY FOUND AT THEIR OWN WORK SHOP

--- ANY UNSAFETY OR RISKY CONDITIONS OR ENVIRONMENT

(D) PRIORITIZING OF PROBLEM OR PROJECT IDENTIFIED FOR TACKLING

AFTER IDENTIFYING LOT OF PROBLEMS OR DIFFICULTIES BY BRAIN--STORMING, NEXT STEP IS TO SCREEN THESE INTO MAJOR OR CRITICAL ONES FOR TACKLING PRIORITIZATION

(1) FOR BEGINNER CIRCLE OR ORGANIZATION

THE FOLLOWING STATED FIG. 3 IS A BETTER WAY TO DETERMINE THE HIGHEST

PRIORITIZED THEME TO BE TACKLED UNDER EVERY MEMBERS CONSENSUS.

SO FAR ANY DATA IS NOT AVAILABLE AT THIS TIME. TO PRIORITIZE A TACKLING SUBJECT AS A THEME. ONLY WAY TO HAVE EVERY MEMBERS CONSENSUS IS BASED ON. AS SHOWN IN FIG. 4 ;

--- MEMBERS AWARENESS AS A PROBLEM OR PROJECT

--- MEMBERS DESIRE TO SOLVE BY THEIR OWN IDEAS AS THEIR FIRST TACKLING THEME

--- MEMBERS RECOGNITION IF CAPABILITY FOR SOLUTION IS ENOUGH

--- MEMBERS RECOGNITION IF SOLUTION IS FINISHED AS PLANNED (SHOULD BE FINISHED WITHIN 3 TO 4 MONTHS)

(2) FOR ADVANCED OR EXPERIENCES CIRCLE OR ORGANIZATION

THE IDENTIFIED BY BRAIN-STORMING ARE SUMMERIZED BY PARETO-CHART BASED ON ' VITAL FEW ' CONCEPT AND ESTABLISHED THE PRIORITIES FOR A PROBLEM OR PROJECT DECISION.

(E) DETERMINATION OF A THEME TO BE TACKLED.

(1) FOR BEGINNER CIRCLE OR ORGANIZATION

AFTER SUMMERIZING THE EVALUATION DATA. THE HIGHEST SCORED ONE IS NOW DETERMINED AS A THEME TO BE TACKLED. AND IS NECESSARY TO DECLARED AND REGISTERED AS THE OFFICAL AT QCC OFFICE OR IS NECESSARY TO INFORM TO OWN BOSS FOR IMPROVEMENT PROJECT.

(2) FOR ADVANCED OR EXPERIENCED CIRCLE OF ORGANIZATION

AFTER PREPARATION OF THE PARETO-CHART. PROPER INTERPRETATION IS CONDUCTED BASED ON TOP MANAGEMENS POLICY. CUSTOMER REQUIREMENT. OR WORK SHOP'S OWN BOUNDARY ENVIRONMENT TO DETERMINE AS A THEME TO BE TACKLED. AND FINAL DECISION IS DISCUSSED WITH MEMBERS FOR THEIR CONSENSUS.

(F) DETERMINATION OF GOAL AND FINISHING SCHEDULE FOR THEME ACCOMPLISHMENT.

ONCE A THEME TO BE TACKLED IS DETERMINED, THEN ITS GOAL AND FINISHING SCHDULE ARE NECESSARY TO ESTABLISH FOR DEFINITE ACHIEVEMENT.

(G) CONFIRMATION OF A THEME ESTABLISHED BY EVERY MEMBERS.

THE THEME ESTABLISHED IS NOW NECESSARY TO BE UNDERSTOOD BY EVERY MEMBERS WHY THE THEME IS PICKED UP AND WHY NECESSARY TO TAKE ACTION FOR SOLUTION OR IMPROVEMENT.

(H) ASSIGNMENT OF SPECIFIC WORKS ON SCHEDULED PROGRAMS

EVERY MEMBERS ARE ASSIGNED FOR EACH SPECIFIC WORKS TO ACCOMPLISH THE PROGRAM ESTABLISHED BY CONSENSUS AGAIN AS SHOWN IN FIG. 5 UNDER THE FULL PARTICIPACTION CONCEPT.

4 IDENTIFICATION OF PRESENT STATUS

THIS PROCESS IS THE MOST IMPORTANT ONE IN QC STORY (QC METHOD) FOR IDENTIFYING WHY THE THEME ESTABLISHED IS NECESSARY TO CORRECT OR IMPROVE.

4-1 COLLECTION OF FACT AND DATA FOR IDENTIFICATION OF REAL STATUS

FACT AND DATA RELATED WITH THE THEME ARE NECESSARY TO COLLECT AT LEAST FOR LAST 5 YEARS OLD STATUS WITH QUANTIFIED NUMBERS, AND WITH JUSTIFIABLE AND TRACEABLE DATA SOURCES.

4-2 STRATIFICATION FACT AND DATA COLLECTED

FACT AND DATA COLLECTED ARE NECESSARY TO STRATIFY WITH MAN, MACHINE, MATERIAL, METHOD, AND ENVIRONMENT (4 M 1 E APPROACH) AND FURTHER STRATIGY AS;

(A) MAN --- BY SEX, AGE, SKILLED OR UNSKILLED, SHIFT, ETC

(B) MACHINE --- BY KINDS OF MACHINE, SERIAL NO., MANUFACTURER, ETC

(C) MATERIAL --- BY MANUFACTURER, HEAT BATCH, LOT, ETC

(D) METHOD --- BY ORGANIZATION, ISSUING DATE, ETC

(E) ENVIRONMENT --- BY YEAR, MONTH, WEEK, DAY, AM, PM, TIME, WORKSHOPS, WEATHER, CLIMATE, TEMPERATURE, ETC

4-3 PREPARATION OF CAUSE AND EFFECT DIAGRAM (FISH-BONE CHART)

FOR SUMMERIZATION OF THE STRATIFIED DATA. THE CAUSE AND EFFECT DIAGRAM (FISH-BONE CHART) ARE RECOMMENDED TO PREPARE FOR FURTHER STUDYING ANY OTHER NECESSARY DATA COLLECTION.

4-4 IDENTIFICATION OF PROBLEM'S STATUS DATA (DISPERSION DATA)

AFTER SUMMERIZATION, PROBLEM OR PROJECT STATUS DATA ARE CLEARLY IDENTIFIED BY HOW MUCH THESE DATA ARE DISPERSED AGAINST THE REQUIREMENTS.

5 ANALYSIS FOR ROOT-CAUSE ISOLATION

5-1 IDENTIFICAION OF PROBABLE CAUSES

THE COLLECTED DATA WITH THE CAUSE AND EFFECT DIAGRAM (FISH-BONE CHART) ARE ANALYZED IF WHICH DISPERSION ARE MOSTLY CONTRIBUTED FOR PROBLEM CAUSES OR PROJECT IMPROVEMENT DISTURBANCES, AND ARE MARKED ON THE MOST PROBABLE ONES OF CAUSE AND EFFECT DIAGRAM (FISH-BONE CHART).

5-2 IDENTIFICATION OF POTENTIAL CAUSES

AMONG OF THE PROBABLE CAUSES IDENTIFIED, FURTHER ANALYSIS ARE CONDUCTED WITH HYPOTHESIS FOR ISOLATION OF THE POTENTIAL CAUSES, WHICH HYPOTHESIS IS ESTABLISHED BY THOROUGH STUDYING OF PROBLEM OR PROJECT IMPROVING STRUCTURE AND TECHNOLOGICAL ANALYSIS.
THESE POTENTIAL ONES ARE ALSO MARKED SPECIFICALLY ON THE DATA OF THE CAUSE AND EFFECT DIAGRAM (FISH-BONE CHART).

5-3 ISOLATION OF ROOT-CAUSE(S)

AFTER SCREENING OF THE POTENTIAL CAUSES, THE MOST RESPONSIBLE OR CONTRIBUTABLE CAUSES ARE ISOLATED BY SIMULATION TEST OR TECHNICAL CALCULALTION OR TECHNOLOGICAL ANALYSIS FOR JUSTIFICATION OF THEIR SCREENINGS.

CAUSE

RESULT

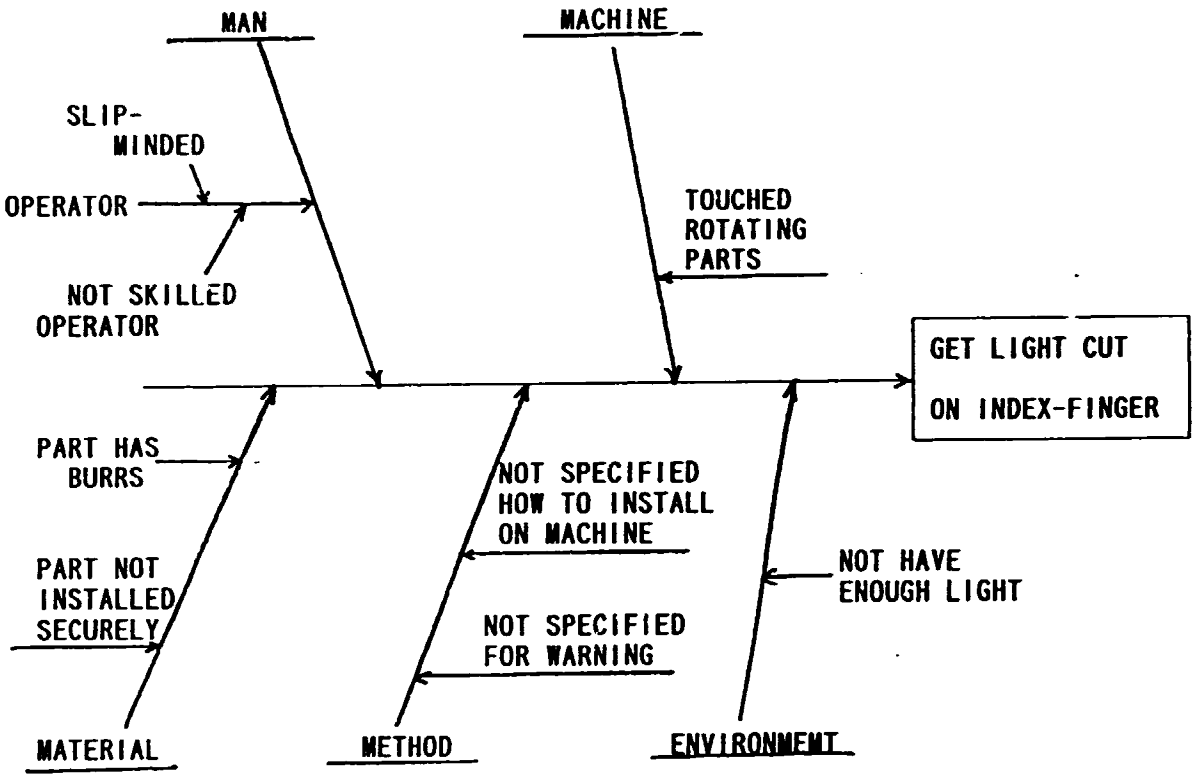


FIG. 6 RECURRENT PREVENTIVE ACTION

6-4 ESTABLISHMENT OF ACTION PLAN FOR IMPLEMENTATION OF THE CORRECTIVE ACTIONS.

WHEN THE BOTH CORRECTIVE ACTIONS ARE ESTABLISHED, IT IS NECESSARY TO ESTABLISH FOR ACTION PLAN SUCH AS,

--- WHO ARE RESPONSIBLE FOR ACTION TAKING

--- WHERE IS THE ACTION TAKING

--- WHAT KINDS OF ACTION IS NECESSARY TO TAKE

--- WHEN IS THE ACTION TAKEN

--- WHY IS THE ACTION NECESSARY TO TAKE

--- HOW IS THE ACTION TAKEN

6-5 FINALLY, PRIOR TO IMPLEMENT THE CORRECTIVE ACTION, ONE LAST CHECK WOULD BE NECESSARY TO CHECK IF ANY OTHER DETRIMENTAL SIDE EFFECTS ARE OBSERVED OR NOT, SUCH AS,

--- IF QUALITY IMPROVED, BUT COST IS UNEXPECTEDLY RAISED

--- IF COST REDUCED, BUT QUALITY ARE DETERIORATED

--- IF QUALITY IMPROVED, BUT PRODUCTION SCHEDULE GOT LATE

--- IF CORRECTIVE ACTIONS DETERMINED ARE FEASIBLE ENOUGH BY MEMBERS BY THEMSELVES

7 IMPLEMENTATION OF CORRECTIVE ACTIONS

7-1 DISSEMINATION OF CORRECTIVE ACTIONS ESTABLISHED

IT IS STRICTLY ADVISED TO BE FULLY COMPLY WITH THE EVERY STEPS OF THE CORRECTIVE ACTIONS ESTABLISHED BY EVERY MEMBERS THAT EACH CORRECTIVE ACTIONS ARE EXPLAINED FOR IMPLEMENTATION PROCEDURES BY SPECIFIC TRAINING PROGRAM TO UNDERSTAND ITS NECESSITY.

7-2 IMPLEMENTATION OF THE CORRECTIVE ACTIONS

AFTER FINISHING OF THE TRAINING, MEMBERS ASSIGNED ARE EXECUTING THE RESPONSIBLE OPERATIONS AS REQUIRED.

7-3 RECORD OF ACTION TAKEN AND RESULTS OBTAINED

WHEN THE CORRECTIVE ACTIONS ARE TAKEN, IT IS NECESSARY TO RECORD ANY ACTIONS TAKEN INTO THE FORMATS FURNISHED FOR TRACEABILITY.

7-4 RETENTION OF RECORDS

THE IMPORTANCE OF RECORDS ARE BASED ON THE CONCEPT THAT THE OBJECTIVE EVIDENCES ARE ONLY VERIFIABLE BY THE AVAILABLE WRITTEN DOCUMENTATIONS, WHICH ARE PHYSICALLY WRITTEN INTO THE FORMATS AT THE EXACT IMPLELMENTING SPOTS.

8 EVALUATION OF THE RESULTS

IT IS READY TO SEE IF THE GAOL ESTABLISHED ARE EXACTLY ACHIEVED BY THE CORRECTIVE ACTIONS WHICH ARE JOINTLY ESTABLISHED BY EVERY MEMBERS CONSENSUS . AS FOR THE RESULTS ARE CONCERNS, THEY MUST BE EVALUATED BY TWO WAYS, ONE IS BY TANGIBLE EFFECTIVENESS, THE THE OTHER IS BY INTANGIBLE VIEWS. SUCH EVALUATION IS BASICALLY CONDUCTED BY CIRCLE OR ORGANIZATION ONESELF, BUT SOMETIMES IT WOULD BE BETTER TO BE EVALUATED BY THE THIRD PARTY TO IDENTIFY IF QC CIRCLE'S PROBLEM HANDLING CAPABILITIES ARE PROGRESSED OR IF EACH ORGANIZATIONAL PROJECT HANDLING CAPABILITIES ARE IMPROVED.

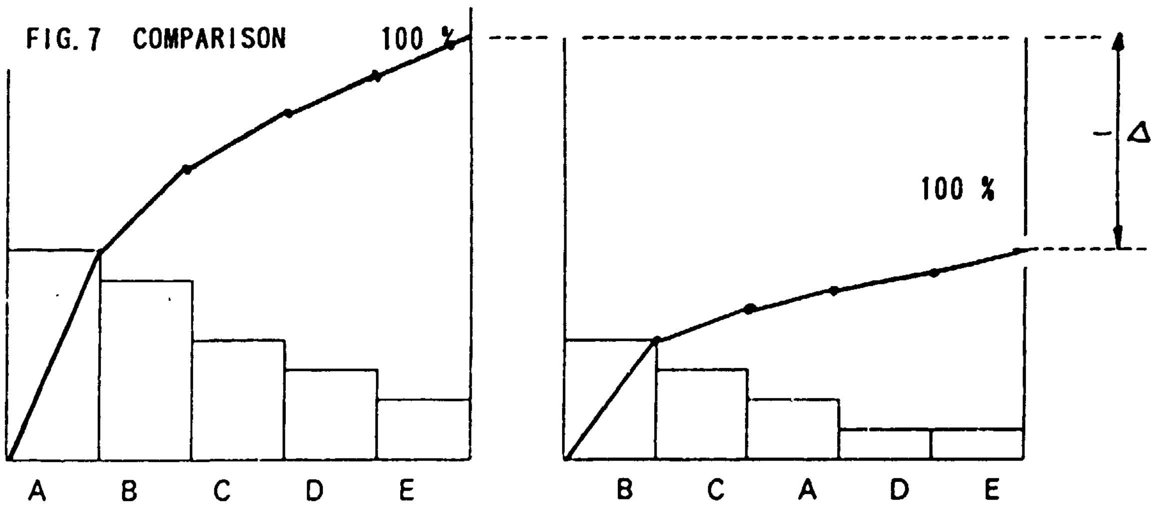
8-1 EVALUATION OF THE RESULT OBTAINED

AFTER THE CORRECTIVE ACTIONS BE IMPLEMENTED, THE RESULT OBTAINED MUST BE CHECKED IF THE GOAL ESTABLISHED ARE ACHIEVED OR NOT, AND ALSO ANY OTHER SIDE-EFFECTS ARE OBSERVED.

8-2 EVALUATION BY TANGIBLE ACHIEVEMENT

THE TANGIBLE EFFECTIVENESS CAN BE IDENTIFIED BY COMPARING WITH GOAL ESTABLISHED AGAINST THE RESULT OBTAINED BY QUANTIFIED DATA. IT IS RECOMMENDED TO USE THE PARETO-CHART FOR COMPARISON BETWEEN THE OLD STATUS AND THE NEWLY ACOMPLISHED ONE AS SHOWN IN FIG. 7.

FIG. 7 COMPARISON



8-3 EVALUATION BY INTANGIBLE EFFECTIVENESS

ALTHOUGH THE INTANGIBLE ACHIEVEMENT ARE RATHER HARD TO EVALUATE COMPARING WITH THE TANGIBLES. THE FOLLOWING STATED COULD BE OBSERVABLE DURING IMPLEMENTING OF SOLUTION OR IMPROVING PROCESSINGS.

--- IMPROVEMENT OF HUMAN RELATIONSHIP BETWEEN LEADER AND MEMBEERS OR MANAGEMENT AND MEMBERS.

--- IMPROVEMENT OF COMMUNICAITON BETWEEN LEADER AND MEMBERS OR MANAGEMENT AND MEMBERS

--- IMPROVEMENT OF MEMBERS CAPABILITY FOR SOLUTION OR IMPROVEMENT

--- IMPROVEMENT OF PROBLEM AWARENESS

TO INDICATE THE INTANGIBLE EFFECTIVENESS, IT IS RECOMMENDED TO USE THE FOLLOWING VISIBLE EVALUATION RADAR CHART FOR COMPETITIVENESS BERWEEN CICLES OR ORGANIZATIONS, IN FIG. 6.
BETWEEN EACH CIRCLES OR ORGANIZATIONS AS SHOWN IN FIG. 8.

9 STANDARDIZATION

THIS STAGE IS CALLED AS 'PERMANENT FIX' OR 'SETTLING STAGE'. BECAUSE THE CORRECTIVE ACTIONS ESTABLISHED COULD BE SPRUNG BACK TO THE FORMER WORSE CONDITION, UNLESS TAKING SOME KINDS OF RECURRENT PREVENTIVE ACTION.

9-1 IF YES, THE CORRECTIVE ACTION ESTABLISHED MUST BE STANDARDIZED

IF OBSERVED 'YES', WHICH MEANS THE CORRECTIVE ACITON ARE EXACTLY MET WITH GOAL ESTABLISHED, THIS CORRECTIVE ACTION MUST BE PUT IN AS WRITTEN FORM, THAT IS CALLED AS SOP (STASNDARD OPERATION PROCEDURES), WHILE REVISING OF THE OLD SOP OR ESTABLISHING OF NEW SOP TO CONDUCT BY DAILY ROUTINE OPERATIONS WITHOUT ANY CONFUSIONS.

FOR SUCH PREVENTION, SOME KINDS OF FOOL-PROOF OR 'POKA YOKE' TYPE OF PROCEDURES ARE REQUESTED TO CONSIDER FOR ESTABLISHMENT OF OPERATIONAL PROCEDURES.

S O P MUST BE PREPARED UNDER 5 V 1 H APPROACH TO SPECIFY

--- WHY IS NECESSARY TO REVISE AND TO FOLLOW

--- WHEN IS NEECESSARY TO CONDUCT AS SPECIFIED

--- WHERE IS NECESSARY TO CONDUCT AS SPECIFIED

--- WHO HAS RESPONSIBILITY TO IMPLEMENT AND TO PERFORM

--- WHAT ACTION IS NECESSARY TO CONDUCT AND TO ASSURE

--- HOW TO USE MACHINE, TOOL, JIG OR FIXTURE IN OPERATION

--- HOW TO ASSURE BY WHAT METHOD AND WHAT INSTRUMENT

--- HOW TO RECORD, HOW TO INFORM WHEN FOUND SOMETHING WRONG

(A) DISSEMINATION OF S O P

AFTER ISSUING OF NEW OR REVISED SOP, IT IS ABSOLUTELY NECESSARY TO INFORM TO THE RELATED OTHER ORGANIZATIONS WHY CHANGED OF SOP, AND DISTRIBUTED AS REQUIRED.

TO IMPLEMENT THE NEW OR REVISED SOP, EVERY RESPONSIBLE OPERATORS ARE NECESSARY TO TRAIN FOR REASON AND BACK-GROUND STORY FOR SOP ESTABLISHMENT TO UNDERSTAND FOR ITS IMPLEMENTATION NECESSITY.

(B) IMPLEMENTATION S O P

THE NEW OR REVISED SOP IS MANDATORILY NECESSARY TO IMPLEMENT INTO THEIR DAILY ROUTINE OPERATION, NOT HAPPENING AGAIN THE SAME DISPERSION WHICH ARE USED TO BE OBSERVED.

(C) RECONFIRMATION OF SOP'S EFFECTIVENESS

AFTER OR DURING IMPLEMENTING OF THE NEW OR REVISED SOP, LEADER OR MANAGEMENT IS CAREFULLY WATCHING THEIR IMPLEMENTING STATUS IF ANY OTHER UNEXPECTED HAPPENING, DIFFICULTIES OR INCONVENIENCIES ARE EXPERIENCED BY OPERATORS.

9-2 IF FOUND N O, WHICH MEANS THE GOAL ESTABLISHED COULD NOT BE ATTAINED AS PROGRAMMED, IT SIMPLY MEANS THAT ONE OR EITHER OF

--- THE DATA COLLECTION PROCEDURES ARE NOT RIGHT

--- DATA COLLECTED ARE NOT JUSTIFIABLE

--- DATA ANALYSIS PROCESSES ARE NOT CORRECT

--- ROOT-CAUSE(s) IDENTIFIED ARE NOT RIGHT ENOUGH FOR ISOLATION

--- CORRECTIVE ACTION IS NOT CORRECTABLE FOR ROOT-CAUSES

--- CORRECTIVE ACTION IS NOT EXACTLY FOLLOWED BY ETC

ARE NOT IMPLEMENTED BY OPERATORS, THAT IT IS ABSOLUTELY NECESSARY TO RETURN TO PARA. 3 TO 9 FOR THOROUGH INTROSPECTION OF EDENTIFICATION FOR WRONG CORRECTIVE ACTION ESTABLISHMENT.

10 INTROSPECTION AND NEXT PLANNING

10-1 WHEN PROCESSING WHOLE PROCEDURES UP TO PARA. 9, MOST OF MEMBERS ARE ENJOYED WHAT THEY HAVE PERFORMED THAT THEY ARE TEND TO RELAXED THEMSELVES, WITHOUT FURTHER INTTOSPECTING IF ANY BETTER ALTERNATIVE MIGHT BE UNNOTICED OR NOT.

(A) IT IS RECOMMENDED THAT ONE MORE TIME THE WHOLE PROCESSES FROM PARA. 3 TO 9 STEPS ARE SELF-EXAMINED IF THEY ARE THE BEST ONES TO TAKE CORRECTIVE ACITON FOR THE INTENDED PURPOSES, ESPECIALLY TO RECONSIDER IF FOLLOWED THE QC STORY(QC METHOD).

(B) IT IS ALSO RECOMMENDED THAT NOT ONLY TO INTROSPECT THE PROCESS OF THE QC STORY(QC METHOD), BUT TO CHECK ON IF AVAILABLE FOR ANY BETTER DATA COLLECTION PROCEDURES, DATA ANALYSIS METHOD, OR USEFUL STATISTICAL TECHNIQUES IN PROCESSINGS.

10-2 AT THE TIME OF Y E S CONDITION,

EVEN THE RESULT IS Y E S, IT IS RECOMMENDED TO EVALUATED IF

THE DEGREE OF ATTAINMENT IS TOO HIGH OR NOT, THAT MEANS THE GOAL ESTABLISHED ARE NOT ADEQUATELY ANALYZED AGAINST THE DATA AVAILABLE OR THE PRESENT STATUS SHOWN DATA WERE NOT REALLY REVEALED THE FACT.

10-3 AT TIME OF N O CONDITION.

IN ADDITION OF THE REEVALUATION OF PARA. 9-2, THE FOLLOWINGS ARE ALSO RECOMMENDED TO ANALYZE;

--- FOR GOAL CONCERNS, IF GOAI ESTABLISHING PROCESS IS ADEQUATE

IF GOAL ESTABLISHED IS CAPABLE ENOUGH FOR FOR MEMBERS ABILITY

--- FOR SCHEDULE CONCERNS, IF SCHEDULE IS TOO TIGHT

IF SCHEDULE IS ESTABLISHED WITH MEMBERS CONCENSUS

IF SCHEDULE IS NEGLECTED BY MEMBERS

--- FOR TEAM WORK CONCERNS, IF EVERY MEMBERS ARE AGREED FOR EVERY PROCESSING STEPS

IF EVERY MEMBERS PRESENT THEIR IDEAS

IF EVERY MEMBERS PARTICIPATE AT EVERY ASSIGNED WORKS

IF EVERY MEMBERS ATTEND AT ANY TIME

IF EVERY MEMBERS CAN USE QC 7 TOOLS

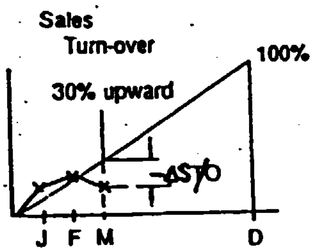
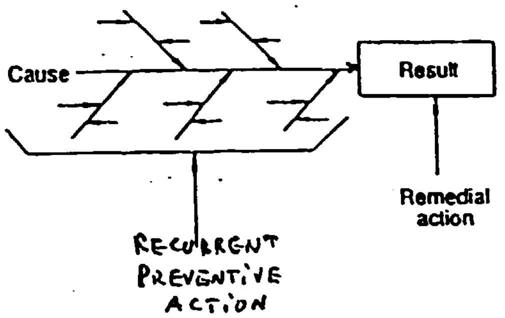
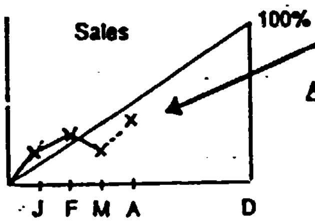
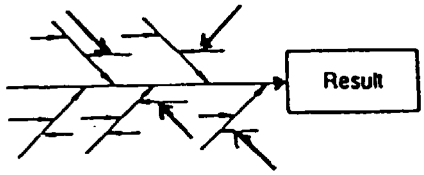
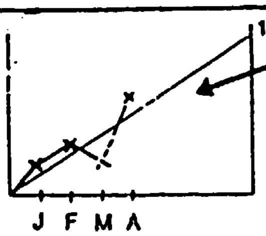
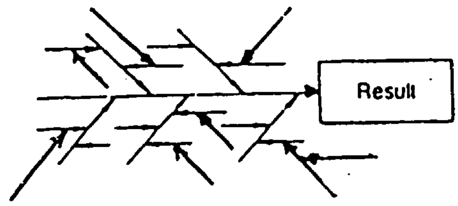
--- FOR PROBLEM OR PROJECT CONCERNS,

IF THEY ARE TOO DIFFICLUT TO ESTABLISH FOR SOLUTION OR IMPROVEMENT

IF THEY ARE TOO DIFFICULT TO SOLVE OR TO IMPROVE

10-4 NEXT F U T U R E PLANNING

WHEN EVERY STEPS OF QC STORY (QC METHOD) ARE FOLLOWED AND CONFIRMED, NEXT PROBLEM OR PROJECT WILL BE TACKLED AMONG OF THE BACK-LOGGED WITHOUT ANY PAUSING OR INTERRUPTION, TO FOLLOW THE NEW T H E M E Q C S T O R Y (Q C M E T H O D).

	Problem	Corrective Action
PAST	 At end of March The Goal can't meet "March" Schedule, Identify Root-Cause(s).	 O O O O O O O O O O X X X X
PRESENT	 At middle of April Goal can be achieved by Corrective Action Established.	Further Studying is Found that  Recurrent Preventive Action are considering, as O O Δ Δ O O Δ Δ O O
FUTURE	 At the end of April Can expect as Shown. However, Competitor's status as such that we will take, After Analysis.	 ⊙ ⊙ ⊙ Δ Δ O Δ ⊙ ⊙ O
COMPETITOR	For Similar Problem, Took: X X X X X X X Taking: X ✱ ✱ ✱ X ✱ ✱ Will Take: ✱ ⊗ ⊗ ⊗ ⊗ ✱ Accordingly, have to change to	

SECTION 4

CHECKLIST FOR THE DEMING APPLICATION PRIZE

ITEM	PARTICULARS
1. POLICY	(1) Policies pursued for management, quality, and quality control (2) Method of establishing policies (3) Justifiability and consistency of policies (4) Utilization of statistical methods (5) Transmission and diffusion of policies (6) Review of policies and the results achieved (7) Relationship between policies and long- and short-term planning
2. ORGANIZATION AND ITS MANAGEMENT	(1) Explicitness of the scopes of authority and responsibility (2) Appropriateness of delegations of authority (3) Interdivisional cooperation (4) Committees and their activities (5) Utilization of staff (6) Utilization of QC Circle activities (7) Quality control diagnosis
3. EDUCATION AND DISSEMINATION	(1) Education programs and results (2) Quality- and control-consciousness, degrees of understanding of quality control (3) Teaching of statistical concepts and methods, and the extent of their dissemination (4) Grasp of the effectiveness of quality control (5) Education of related company (particularly those in the same group, subcontractors. consignees, and distributers) (6) QC Circle activities (7) System of suggesting ways of improvements and its actual conditions
4. COLLECTION, DISSEMINATION AND USE OF INFORMATION ON QUALITY	(1) Collection of external information (2) Transmission of information between divisions (3) Speed of information transmission (use of computers) (4) Data processing, statistical analysis of information and utilization of the results

5. ANALYSIS	(1) Selection of key problems and themes (2) Propriety of the analytical approach (3) Utilization of statistical methods (4) Linkage with proper technology (5) Quality analysis, process analysis (6) Utilization of analytical results (7) Assertiveness of improvement suggestions
6. STANDARD-IZATION	(1) Systematization of standards (2) Method of establishing, revising, and abolishing standards (3) Outcome of the establishment, revision, or abolition of standards (4) Contents of the standards (5) Utilization of statistical methods (6) Accumulation of technology (7) Utilization of standards
7. CONTROL	(1) Systems for the control of quality and such related matters as cost and quantity (2) Control items and control points (3) Utilization of such statistical control methods as control charts and other statistical concepts (4) Contribution to performance of QC Circle activities (5) Actual conditions of control activities (6) State of matters under control
8. QUALITY ASSURANCE	(1) Procedure for the development of new products and services (analysis and upgrading of quality, checking of design, reliability, and other properties) (2) Safety and immunity from product liability (3) Process design, process analysis, and process control and improvement (4) Process capability (5) Instrumentation, gauging, testing, and inspecting (6) Equipment maintenance, and control of subcontracting, purchasing, and services (7) Quality assurance system and its audit

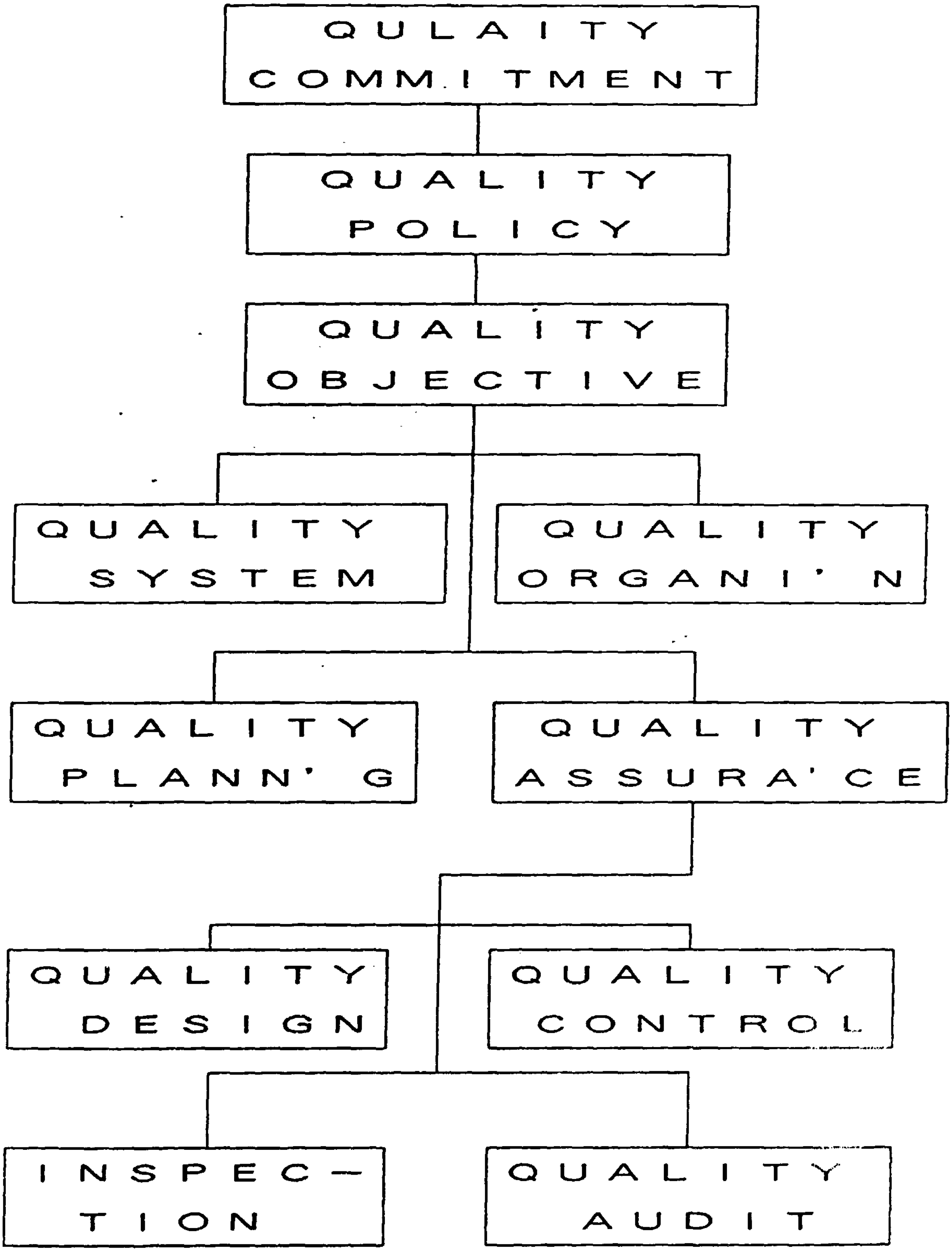
8. QUALITY ASSURANCE	(8) Utilization of statistical methods (9) Evaluation and audit of quality (10) Actual state of quality assurance
9. RESULTS	(1) Measurement of results (2) Substantive results in quality, services, delivery time, cost, profits, safety, environment, etc. (3) Intangible results (4) Measures for overcoming defects
10. PLANNING FOR THE FUTURE	(1) Grasp of the present state of affairs and the concreteness of the plan (2) Measures for overcoming defects (3) Plans for further advances (4) Linkage with the long-term plans

. Comparison of Concepts for Deming Prize & Baldridge Awards

	Deming Prize	Baldrige Award
Purpose	To Award Prize To Those Companies Which Are Reiognized As Having Successfully Applied CWQC Based on Statiscal Quality Control and Which Are Likely To Keep Up In The Future.	To Promote Quality Awareness, RecogNize Quality Achievements Of U.S.Companies, And To Poblicize Successful Quality Strategies.
Judging Criteria	1 Page Checklist	23 Page Checklist
Emphasis Statistical Method	More Statistical Methods Are Necessary To Consistently Use Throughout All Aspect.	Overall Importantce
Recipient	Every Company Over A Minimum Standards More Than 70 POINTS (rating)	Max. Of 2 awards Per Category Per Year
Timeline	A Year	About 6 Months
Tupe Of Award	A Recognition	An Element Of Competition
Emphasis	More Inprocessing Oriented	More Result Oriented

SECTION 5

QUALITY



QUALITY COMMITMENT

HORIZON

VISION

STRATEGY

— TACTICS

— OPERATION

MISSION

FOR SURVIVAL

- VISION (FOR NEXT 5
10 YEARS)

- HOW THE COMPANY BE STOOD IN MARKET UNDER SURVIVAL AN AND DOMINANT COM-PETITIVITY
- WHAT TECHNOLOGY BE IMPLEMENTED FOR NEW PRODUCT OR SERVICE
- WHAT STRUCTURE BE ORGANIZED

FOR SURVIVAL AND DOMINANT COMPETI-TIVITY SUSTENANCE THROUGH CUSTOMER SATISFACTION

QUALITY STRATEGY

(TO BE ISSUED BY)

- HORIZON
- VISION
- COMPETITIVITY EDGE
- CUSTOMER SATISFACTION STATUS
- BENCH MARKS STUDYING RESULTS
- AS ONE COMPONENT OF BUSINESS STARATEGY

TO BE COVERED CHRONOLOGICALLY;

- CUSTOMER ORIENTED PRODUCT OR SERVICE DEVELOPMENT
- QULITATIVE AND QUANTITATIVE GOALS
- IMPROVEMENT FOR DESIGN TECHNOLOGY
- IMPROVEMENT FOR PROCESS TECHNOLOGY
- HUMAN BEHAVIOR IMPROVEMENT
- EDUCATION AND TRAINING PROGRAM IMPROVEMENT

QUALITY POLICY

DEFINITION:

THE OVERALL QUALITY iNTENTIONS AND DI– RECTION OF AN ORGA– NIZATIONS AS REGARD QULITY, AS FORMALLY EXPRESSED BY TOP MANAGEMENT.

(BY ISO 8402)

QUALITY POLICY

- DECISION FOR QUALITY LEVEL AND GRADE OF PRODUCT OR SERVICE
- DISSEMINATION FOR PRODUCT OR SERVICE QUALITY CHARACTER-ISTICS
- DISSEMINATION FOR QUALITY ACCOMPLI-SHMENT APPROACHES
- DESIGNATION FOR RESPONSIBILITY OF ASSIGNED QUALITY ACCOMPLISHMENT TO EACH PERSONNEL

QUALITY OBJECTIVES

STATEMENT FOR QUANTITATIVE PRODUCT OR SERVICE QUALITY BY MEASURABLE AND VERIFIABLE NUMBERS.

- DEGREE OF CUSTOMER SATISFACTION CONSISTENT WITH PROFESSIONAL STANDARDS AND ETHICS.

- DEGREE OF CONTINUOUS IMPROVEMENT OF THE PRODUCT OR SERVICE WHILE IN CUSTOMERS HANDS.

— SPECIFIC CONSIDERATION TO THE REQUIREMENTS OF SOCIETY AND THE ENVIRONMENT.

— EFFECTIVENESS AND EFFICIENCY IN PROVIDING THE PRODUCT AND SERVICE.

— IDENTIFIED CUSTMERS NEEDS AND TOP MANAGEMENT COMMITMENT

(EXAMPLE)

1. CLEAR DEFINITION OF CUSTOMER NEEDS WITH APPROPRIATE QUALITY MEASURES.
2. PREVENTIVE ACTION AND CONTROL TO AVOID CUSTOMER DISSATISFACTION.
3. OPTIMIZING QUALITY-RELATED COSTS FOR THE REQUIRED PERFORMANCE AND GRADE OF SERVICE.
4. CREATION OF A COLLECTIVE COMMITMENT TO QUALITY WITHIN THE SERVICE ORGANIZATION.

QUALITY SYSTEM

DIFINITION:

THE ORGANIZATIONAL STRUCTURE, RESPONSIBILITIES, PROCEDURES, PROCESSES AND RESOURCES FOR IMPLEMENTING QUALITY MANAGEMENT

(ISO 8402)

5. CONTINUOUS REVIEW OF PRODUCT AND SERVICE REQUIREMENTS AND ACHIEVEMENT TO IDENTIFY OPPORTUNITIES FOR PRODUCT OR SERVICE QUALITY IMPROVEMENT.

6. PREVENTION OF ADVERSE EFFECTS BY THE PRODUCT OR SERVICE ORGANIZATION ON SOCIETY AND THE ENVIRONMENT.

3. TO ESTABLISH CAREER DEVELOPMENT PROGRAM FOR EVERY EMPLOYEES

4. TO DEVELOP FOR EDUCATION AND TRAINING SCHEME TO COMPLY WITH

5. TO MOTIVATE AND CHALLENGE EMPLOYEES FOR FOSTERING SELF-STUDYING AND PARTICIPATING ENVIRONMENT AND CIRCUMSTANCE WITHIN EVERY WORKSHOPS

6. TO ORGANIZE FOR QC CIRCLE IMPLEMENTATION PROGRAM BY FLOOR PEOPLE

7. TO IMPLEMENT EDUCATION AND TRAINING PROGRAM

8. TO HAVE THEM INSTALL QC CIRCLE AT OWN WODKSHOPS

QUALITY PLAN

DEFINITION:

ESTABLISH EVERY NECESARY ACTIONS REQUESTED OR NEEDED FOR THE CUSTOMERS – INTERNAL & EXTERNAL SATISFACTION ON A SPECIFIC RESPONSIBILITIES OR DUTIES.

PLANNING ELEMENT

DETERMINATION OF QUALITY REQUIRED OR NEEDED FOR CON- FORMING WITH CUST- MER·S REQUIREMENT

ESTABLISHMENT OF OBJECTIVES

DETERMINATION OF AUTHORITY AND RESPONSIBILITY

ESTABLISHMENT OF PROCESS AND METHOD

ESTABLISHMNET OF PROCEDURES

ESTABLISHMENT OF WORK INSTRUCTIONS

ESTABLISHMENT OF QUALTIY ASSURANCE PROCEDURES

SECTION 6

TQM

TOTAL QUALITY CONTROL

TOTAL QUALITY MANAGEMENT

TOTAL QUALITY SYSTEM

TOTAL QUALITY PROGRAM

TOTAL QUALITY IMPROVEMENT

REENGINEERING AND TOTAL QULITY

TQM CONCEPT

1. TQM STARTS AT THE TOP.

2. TQM REQUIRES TOTAL INVOLVEMENT.

3. TQM FOCUSES ON THE CUSTOMER.

4. TQM USES TEAMS.

5. TQM REQUIRES TRAINING FOR EVERYBODY.

6. TQM USES TOOLS TO MEASURE AND FOLLOW PROGRESS.

(BY MR. JOHN T. BURR
FROM QUALITY PROGRESS,
MARCH 93, PAGE 87 - 88)

TQM IMPLEMENTATION MODEL

1. CREATE A STEERING COMMITTEE TO OVER SEE THE IMPLEMENTATION PROCESS.

2. DEVELOP MEASURES OF QUALITY AND QUALITY COSTS BEFORE THE IMPORVEMENT PROGRAM BEGINES.

3. PROVIDE SUPPORT TO THE TEAMS.

4. REWARD OR CELEBRATE SUCCESS.

(BY MR. JOHN T. BURR,
FROM QULITY PROGRESS, MARCH 93,
PAGE 87 - 88)

THE PROMINENT PROBLEM ON TQM:

(BY PROF. ROLLIE JONES AND
WENDELL W. SHIVERS
IN " LOGISTIC SOECTRYN ".
VOL. 26. ISSUE 4. WINTER 1992)

1. MIDDLE MANAGEMENT FAILURE TO RESPOND TO AND IMPLEMENT EXECUTIVE DIRECTION.

2. FAILURE TO COMMUNICATE AT ALL LEVELS OF THE ORGANIZATION

3. FAILURE TO FORM AND NURTURE TEAM BUILDING.

4. FAILURE OF MANAGEMENT TO PROVIDE AND REINFORCE EMPOWERMENT OR FAILURE OF EMPLOYEESS TO ACCEPT/TRUST EMPOWERMENT.

5. FAILURE TO SPEND THE UP FRONT TIME AND EFFORT TO PROPERLY PLAN THE TRANSITION PHASE FROM OLD PRACTICE TO TQM.

RECOMMENDATIONS:

1. DECISIVE MANAGEMENT

IS COMPRISED OF A POSITIVE ATTITUDE AND PHILOSOPHY FOR GETTING THINGS DONE THROUGH THE DIRECT PARTICIPATION OF THE EMPLOYEES.

FOR THAT, THE DECISION-MAKING PROCESS MUST BE SHARED WITH EMPLOYEES THROUGH ENCOURAGED PARTICIPATION, AND EMPOWERING EMPLOYEES TO ACT AND DECIDE IN TIMES REQUIRING INSTANT ACTION.

THIS REQUIRES TO DESIGN TO EMPLOY ALL THE NECESSARY TO DEVELOP AND MAINTAIN A STRONG, PROUD AND DY--- NAMIC WORK FORCE. THIS REQUIRES THE CAPABILITY TO TRAIN THE WORKERS, PROVIDE THE POLICIES, PROCESS, AND PROCEDURES, PROVIDE THE RIGHT EQUIPMENT, ENSURE THAT EMPLOYEES OVER THEIR HARDLES, SET ACHIEVABLE GOALS, REWARD EMPLOYEES FOR POSITIVE PERFORMANCE, AND MAKE THEM THE STARS OF THE SHOW.

CONCLUSION:

ALL THE INFORMATION IS EASY TO PUT IN WRITING, HOWEVER, PRACTICAL APPLICATION IS ANOTHER ENDEAVOR.
DETAILED PLANNING REQUIRES MUCH TIME AND PATIENCE. ABOVE ALL IT REQUIRES THE PARTICIPATION OF ALL EMPLOYEES FROM THE VERY BEGINNING. GET THEM INVOLVED FROM THE CONCEPTUAL PHASE AND KEEP THEM INVOLVED. AS TIME PASSES AND TRUST IS INCREASED, THE TEAM CONCEPT OF EMPLOYEE AND MANAGEMENT WORKING TOGETHER WILL EMERGE AND BECOME A REALITY. THE REWARDS WILL EXCEED ALL EXPECTATIONS.

SECTION 7

TQC IMPLEMENTATION PROGRAM

	YEAR / ACTIVITIES	1992					1993					1994					1995					'96	
		2	4	6	8	10	2	4	6	8	10	2	4	6	8	10	2	4	6	8	10	2	4
1	ISSUE TOP MANAGEMENT COMMITMENT FOR TQC/QCC IMPLEMENTATION																						
2	ORGANIZE TQC STEERING COMMITTEE (OR) COUNCIL																						
3	ASSIGN MEMBERS OF TQC STEERING COMM (OR) COUNCIL																						
4	ORGAN'Z TQC OFFICE AS FOR TQC COMM OR COUNCIL SECR'Y & TQC PROMOTION																						
5	ASSIGN TQC OFFICE MANAGER AND FACILITATORS																						
6	ESTABLISH TQC IMPLELMENTING POLICY AND PROGRAM BY TQC COMM OR COUNCIL																						
7	VISIT VARIOUS IMPLEMENTED COMPANY OR COUNTRY BY TOP AND SR MANAGEMENTS AND TQC MANAGER & FACILITATORS																						
8	ESTABLISH TQC IMPLEMENTING PLAN & SCHEDULE BY TQC OFFICE																						
9	TRAIN TOP AND SR MANAGEMENT																						
10	TRAIN TQC MANAGER AND FACILITATORS																						
11	PREPARE EDUCATION MATERIAL FOR TQC IMPLEMENTATION AND QC 7 TOOLS																						

	YEAR / ACTIVITIES	1992					1993					1994					1995					'96		
		2	4	6	8	10	2	4	6	8	10	2	4	6	8	10	2	4	6	8	10	2	4	6
12	IMPLEMFNT EDUCATION AND TRAINING PROGRAM TO EACH LEVELS AS SCHEDULE																							
13	FOR EVERY MANAGERS WHO FINISHED THE ABOVE EDUCATIONS, SHAKE-DOWN OWN'S WORKSHOP TO IDENFY OWN'S WEAKNESS AND STRONG POINTS WITH SUBORDINATES																							
14	FOR EXCERCISE OF QC STORY & EFFECTIVE DATA UTILIZATION, ESTABLISH A PROJECT (EASIEST ONE) AND SOLVE IT, AND REPEAT SUCH EXCERCISE FOR NEXT EASIER ONES. IF FAMILIARISED, TACKLE CRITICAL OR IMPORTANT ONES FOR IMPROVEMENT																							
15	CONDUCT QCC EDUCATIONS FOR SUPERVISORS																							
16	INSTALL PILOT CIRCLE BY VOLUNTEERED SUPERVISOR																							
17	PREPARE MBP DRAFT BY TQC OFFICE																							
18	GET APPROVAL OF TQC COMM/COUNCIL & TOP MANAGEMENT																							
19	ESTABLISH TOP MGT ANNUAL GOALS																							
20	DEPLOY GOAL TO EVERY MANAGEMENT & IMPLEMESNT MBP																							

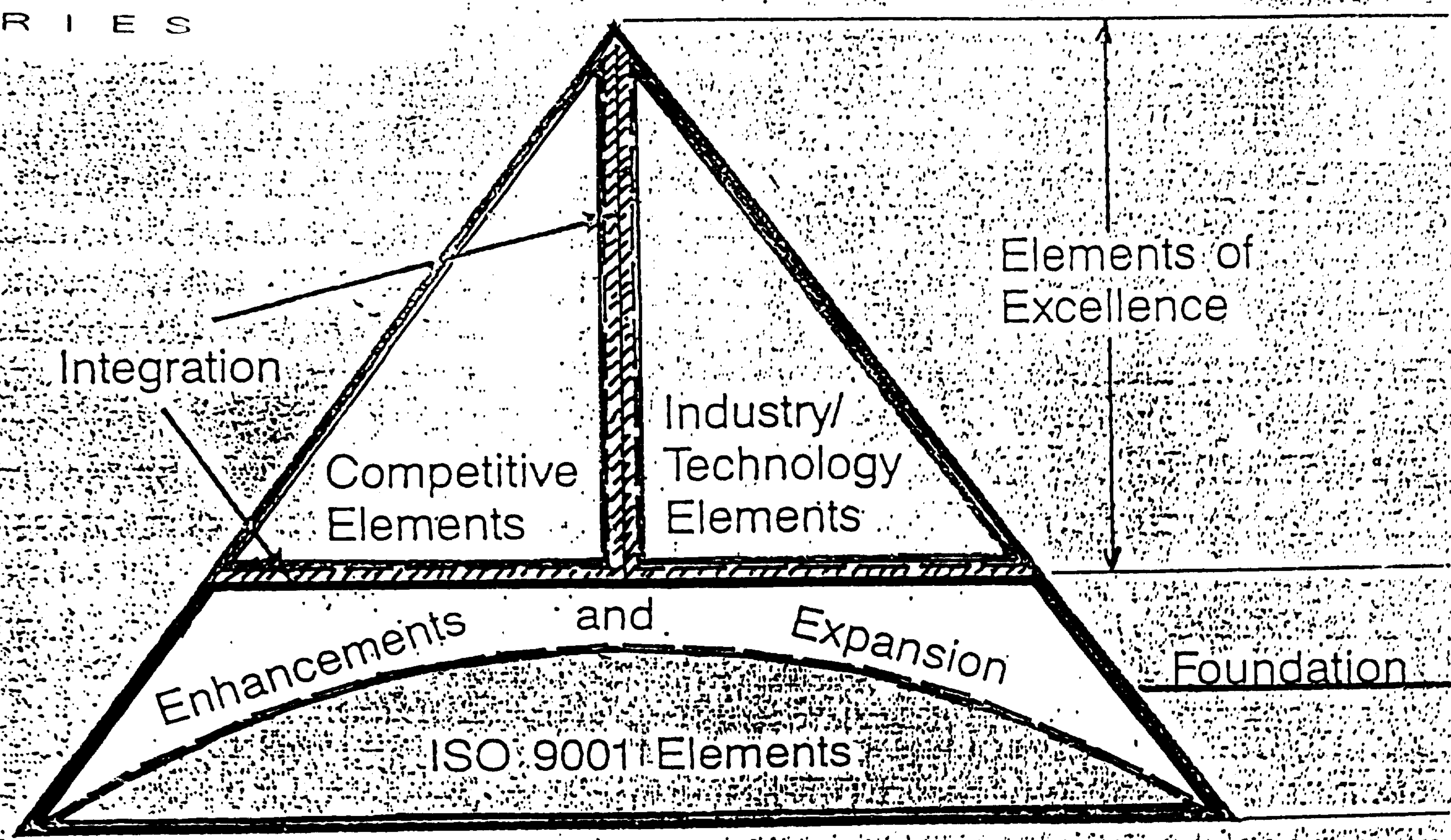

Integration
Competitive Elements
Industry/ Technology Elements
Elements of Excellence
Enhancements and Expansion
Foundation
ISO 9001 Elements

Figure 3. Competitive elements

Continuous Improvement. A system for planning and achieving continuous improvement, whether it be process-oriented or product-specific, should be developed, documented, and implemented. This should not be limited to production processes, but should include improvement of administrative processes as well.

Performance Information. A key to improvement (as well as to control) is effective use of information related to performance of processes, products, and services. Procedures should be established to provide a basis for reporting, in a timely manner, performance of processes, products, and services, with both in-house measurements and measurements taken by the customer. It might also be extended back into the supplier base.

Customer Satisfaction. Listening to the voice of the customer is an essential activity for every company. Systems, procedures, and resources must be in place to understand customer requirements, to manage customer relationships, to measure customer satisfaction, and to ensure appropriate resolution of customer dissatisfaction.

Cost of Quality Systems. Related to performance information is the need for a system to calculate and track the economics of quality in the form of quality costs. Those categories of costs relevant to quality, nonconformance, appraisal, etc. should be tracked and reported.

Quality Planning. Planning for quality in products, processes, and services, either new, transferred, or changed, is a necessary element in a successful startup. Planning must emphasize how analyzing a particular product, process, or service fits into the total quality system.

Figure 4. Examples of basic industry/technology elements

Workstation Management. Procedures and schedules for controlling and managing workstations and facilities used in quality activities must be established to ensure that environmental and ergonomic conditions are maintained.

Employee Safety and Health. The safety and well-being of employees, as well as maintenance of a safe working environment, are crucial in protecting the most important asset: people.

Preventive Maintenance. Requires ongoing preventive maintenance of equipment and machinery to minimize downtime.

Ongoing Reliability Assurance. Requires that procedures be in place to ensure that product continues to meet reliability requirements (above and beyond conventional inspection and test). This typically includes user audits, reliability testing, and life testing.

Diagnostic Tool Control. Diagnostics such as software and firmware are increasingly used as debugging tools. Thus, the dependency on them requires control per revision and type, storage in proper environmental conditions, backups, and a method for testing diagnostic tools.

Regulatory Agency/Product Safety. Processes and products are subject to regulatory requirements for product safety relative to design, qualification, and manufacturing. These requirements must be identified and communicated through the quality system.

► Figure 2. A summary of each element of ISO 9001

Management Responsibility. Requires that quality policy be defined, documented, and communicated throughout the organization; that responsibility regarding quality be clearly defined; that in-house resources are available for verification activities; that a management representative be appointed to ensure quality system requirements are being met; and that the management representative lead a management review periodically to ensure the continuing suitability and effectiveness of the quality system.

Quality System. Requires a quality system that meets the criteria of the applicable ISO 9000 series standard be established and maintained (documented as a quality system manual and implemented) as a means of ensuring that product conforms to requirements.

Contract Review. Requires review of contracts to ensure requirements are adequately defined and to ensure the capability exists to meet the requirements.

Design Control. Requires procedures for controlling and verifying product design to ensure that specified requirements are being met and to include procedures for design/development planning, design input/output, design verification, and design changes.

Document Control. Requires establishing and maintaining procedures for controlling documentation through approval, issue, change, and modification.

Purchasing. Requires that purchased product conform to specified requirements; ensured through subcontractor assessments, clear and accurate purchasing data, and verification of purchased product.

Purchaser-Supplied Product. Requires procedures for verification, storage, and maintenance of purchaser-supplied product.

Product Identification and Traceability. Requires procedures for identifying product during all stages of production, delivery, and installation, and individual product or batch-unique identification as needed.

Process Control. Requires procedures to ensure that production and installation processes are carried out under controlled conditions, which include documentation, monitoring and control of suitable process and product characteristics, use of approved equipment, and criteria for workmanship.

Inspection and Testing. Requires that procedures for inspection and test at receiving, in-process, and final stations be in place as documented in quality plan; must include maintenance of records and disposition of product.

Inspection, Measuring, and Test Equipment. Requires procedures for selection, control, calibration, and maintenance of measuring and test equipment.

Inspection and Test Status. Requires that markings, stamps, or labels be affixed to product throughout production and installation to show conformance or nonconformance to tests and inspections.

Control of Nonconforming Product. Requires control of nonconforming product to ensure it is not inadvertently used; includes identification, segregation, and evaluation.

Corrective Action. Requires procedures for investigating causes of nonconformance, taking action to rectify them, and creating controls to prevent future occurrence.

Handling, Storage, Packaging, and Delivery. Requires procedures for handling, storage, packaging, and delivery of product.

Quality Records. Requires procedures for identification, collection, indexing, filing, and storage of quality records.

Internal Quality Audits. Requires a system of internal audits to verify whether quality activities comply with requirements and to determine the effectiveness of the quality system.

Training. Requires procedures for identifying training needs and providing training for all personnel to meet those needs.

Servicing. Requires procedures for performing servicing as required by contract.

Statistical Techniques. Requires procedures for identifying the use of statistical techniques in process, product, and service.

Quality Assurance

Ichiro MIYAUCHI

(J U S E)

Union of Japanese Scientists and Engineers

2

UNION OF JAPANESE SCIENTISTS AND ENGINEERS
(NIHON KAGAKU GIJUTSU RENMEI)
5-10-11, Sendagaya, Shibuya-ku, Tokyo 151, JAPAN

Preface

A) Quality assurance Concept in Japan are prevailed in every industries for customer satisfaction assurance for many years . However, so-called national quality assurance standards have never been established by anybody at any time ever since implementing of quality concept from 1950 to date. Frankly speaking, without quality assurance standards, every Japanese enterprises have devoted for customer how to improve quality and to assure for quality and the result obtained and revealed today are not necessary to explain anymore that every Japanese industries have developed their own quality control and assurance standards by their own creative ideas only for customers satisfaction.

B) This approach is, according to Prof. H. Kume, called as sellers-oriented one, and the other is called as buyers- oriented which are observable, as MIL-Q-5923C, or MIL-Q-9858A, for directive type of quality assurance issued by buyers to manufacturers. Accordingly, our presentation are more oriented from sellers view how to acquire customer satisfaction from the very beginning market research, through to planning, design, production, sales and services, whcih are also called as offensive quality control and assurance.

C.) As for your reference, here is inclosed other countries quality assurance standards in Table 1.

1. Definition of Quality assurance

(A) ISO 8402 defines

Quality assurance is

"All those planned and systematic actions necessary to provide adequate confidence that a product and service will satisfy given requirements for quality".

(B) ANSI/ASQC (A•3—1978)

"All those planned *or* systematic actions necessary to provide adequate confidence that a product or service will satisfy given *needs*".

(C) JIS Z 8101

"Systematic actions performed by manufacturers, to fully assure for the quality requirements by consumers".

(D) Dr. K. Ishikawa mentioned,

"To assure quality which consumers be able to buy and to use with confidence and satisfaction, and still to be able to use last long".

(E) In general

Quality assurance is

(i) Not to give any annoyance to customer, once if it dose, must be compensate by all means
————sufficient conditions

(ii) To have customer full satisfaction, any systematic assuring action performed by manufacturers
————necessary conditions

Table 1 Quality Assurance Standards

Standards body	Quality management and quality assurance standards: guidelines for selection and use	Quality systems: model for quality assurance in design/development, production, installation, and servicing	Quality systems: model for quality assurance in production and installation	Quality systems: model for quality assurance in final inspection and test	Quality management and quality system elements: guidelines
ISO	ISO 9000: 1987	ISO 9001: 1987	ISO 9002: 1987	ISO 9003: 1987	ISO 9004: 1987
Australia	AS 3900	AS 3901	AS 3902	AS 3903	AS 3904
Austria	OE NORM-PREN 29000	OE NORM-PREN 29001	OE NORM-PREN 29002	OE NORM-PREN 29003	OE NORM-PREN 29004
Belgium	NBN X 50-002-1	NBN X 50-003	NBN X 50-004	NBN X 50-005	NBN X 50 002-2
Canada	—	—	—	—	CSA Q420-87
China	GB/T 10300.1 - 88	GB/T 10300.2 - 88	GB/T 10300.3 - 88	GB/T 10300.4 - 88	GB/T 10300.5 - 88
Denmark	DS/EN 29000	DS/EN 29001	DS/EN 29002	DS/EN 29003	DS/EN 29004
European Community	EN 29000-1987	EN 29001-1987	EN 29002-1987	EN 29003-1987	EN 29004-1987
Finland	SFS-ISO 9000	SFS-ISO 9001	SFS-ISO 9002	SFS-ISO 9003	SFS-ISO 9004
France	NF X 50-121	NF X 50-131	NF X 50-132	NF X 50-133	NF X 50-122
Hungary	MI 18990-1988	MI 18991-1988	MI 18992-1988	MI 18993-1988	MI 18994-1988
India	IS: 10201 Part 2	IS: 10201 Part 4	IS: 10201 Part 5	IS: 10201 Part 6	IS: 10201 Part 3
Ireland	IS 300 Part 0/ ISO 9000	IS 300 Part 1/ ISO 9001	IS 300 Part 2/ ISO 9002	IS 300 Part 3/ ISO 9003	IS 300 Part 0/ ISO 9004
Italy	UNI/EN 29000-1987	UNI/EN 29001-1987	UNI/EN 29002-1987	UNI/EN 29003-1987	UNI/EN 29004-1987
Malaysia	—	MS 985/ ISO 9001-1987	MS 985/ ISO 9002-1987	MS 985/ ISO 9003-1987	—
Netherlands	NEN-ISO 9000	NEN-ISO 9001	NEN-ISO 9002	NEN-ISO 9003	NEN-ISO 9004
New Zealand	NZS 5600: Part 1-1987	NZS 5601-1987	NZS 5602-1987	NZS 5603-1987	NZS 5600: Part 2-1987
Norway	NS-EN 29000: 1988	NS-EN 29001: 1988	NS-ISO 9002	NS-ISO 9003	—
South Africa	SABS 0157: Part 0	SABS 0157: Part I	SABS 0157: Part II	SABS 0157: Part III	SABS 0157: Part IV
Spain	UNE 66 900	UNE 66 901	UNE 66 902	UNE 66 903	UNE 66 904
Sweden	SS-ISO 9000: 1988	SS-ISO 9001: 1988	SS-ISO 9002: 1988	SS-ISO 9003: 1988	SS-ISO 9004: 1988
Switzerland	SN-ISO 9000	SN-ISO 9001	SN-ISO 9002	SN-ISO 9003	SN-ISO 9004
Tunisia	NT 110.18-1987	NT 110.19-1987	NT 110.20-1987	NT 110.21-1987	NT 110.22-1987
United Kingdom	BS 5750: 1987: Part 0: Section 0.1 ISO 9000/EN 29000	BS 5750: 1987: Part 1: ISO 9001/EN 29001	BS 5750: 1987: Part 2: ISO 9002/EN 29002	BS 5750: 1987: Part 3: ISO 9003/EN 29003	BS 5750: 1987: Part 0: ISO 9004/EN 29004
USA	ANSI/ASQC Q90-1987	ANSI/ASQC Q91-1987	ANSI/ASQC Q92-1987	ANSI/ASQC Q93-1987	ANSI/ASQC Q94-1987
USSR	—	40.9001-88	40.9002-88	—	—
West Germany	DIN ISO 9000	DIN ISO 9001	DIN ISO 9002	DIN ISO 9003	DIN ISO 9004
Yugoslavia	JUS A.K. 1.010	JUS A.K. 1.012	JUS A.K. 1.013	JUS A.K. 1.014	JUS A.K. 1.011

This table originally appeared in the March 1990 issue of Quality News, which is published by the Institute of Quality Assurance London.

2. Quality

A) The customer satisfaction, or full satisfaction are now necessary to define as "big quality or broad quality" as shown in Fig. 1.

B) Also, product (hardware) quality are differing from at various phases as shown in Fig. 2 to assure for customer satisfaction.

Accordingly, quality covered from planning to customer use phase can't be assured by mere conventional quality assurance or quality control department but every employee in every department is necessary to participate in his quality assurance functions. This is the main background TQC (Company-wide quality control) concept advocation.

Under TQC (CWQC) concept, quality is not defined as just hardware oriented quality (performance, function safety or reliability, etc.) for exterior end users, but is interpretted as much wider range of quality (broader quality or big quality) which is requested to be assured by the personnel involved in such area – as shown in Fig. 3–administrative, personnel, finance, labor relations, public relations, welfare, etc. in white-collar working shops for in-house/customers. These sectors have sufficient responsibility for daily-routine work quality, cost quality, time quality, and behavior quality as shown in Fig. 1.

C) Kinds of Quality

According to Dr. T. Asaka, Quality of product cycle are designated, as shown in Fig 4 and Fig 5, from Q_0–Q_{11} related with the location of each please.

(1) Q_0 : Customer reguirement /needs/demands in use, the final destination for customer satisfaction
(2) Q_1 : Customer requirement for procurement
(3) Q_2 : Quality goal for research and development organizations
(4) Q_3 : Quality instruction (Goals) specified by top management for future new products
(5) Q_4 : Quality requirement specified in drawing and specifications
(6) Q_5 : Quality of new prototype product
(7) Q_6 : Process design achievable Quality
(8) Q_7 : Quality of supplied products
(9) Q_8 : Quality in each processing products
(10) Q_9 : Quality assured by inspection and test
(11) Q_{10} : Quality when products are delivered to customer
(12) Q_{11} : Quality of servicing by product support personnel to Customers
(13) Quality in audit : Quality indentified by quality audit by top management or TQC office or Quality assurance office
(14) Quality in claim handling : Quality for the efficiency or effectiveness of customer claim or complants handlings.

Especially, Q_1, Q_3, Q_4, Q_9 & Q_{10} are closely related with each others and their levels are quite differing from as shown in Fig. 5 that, when discussing quality problem, it is very important to identify which quality level are.

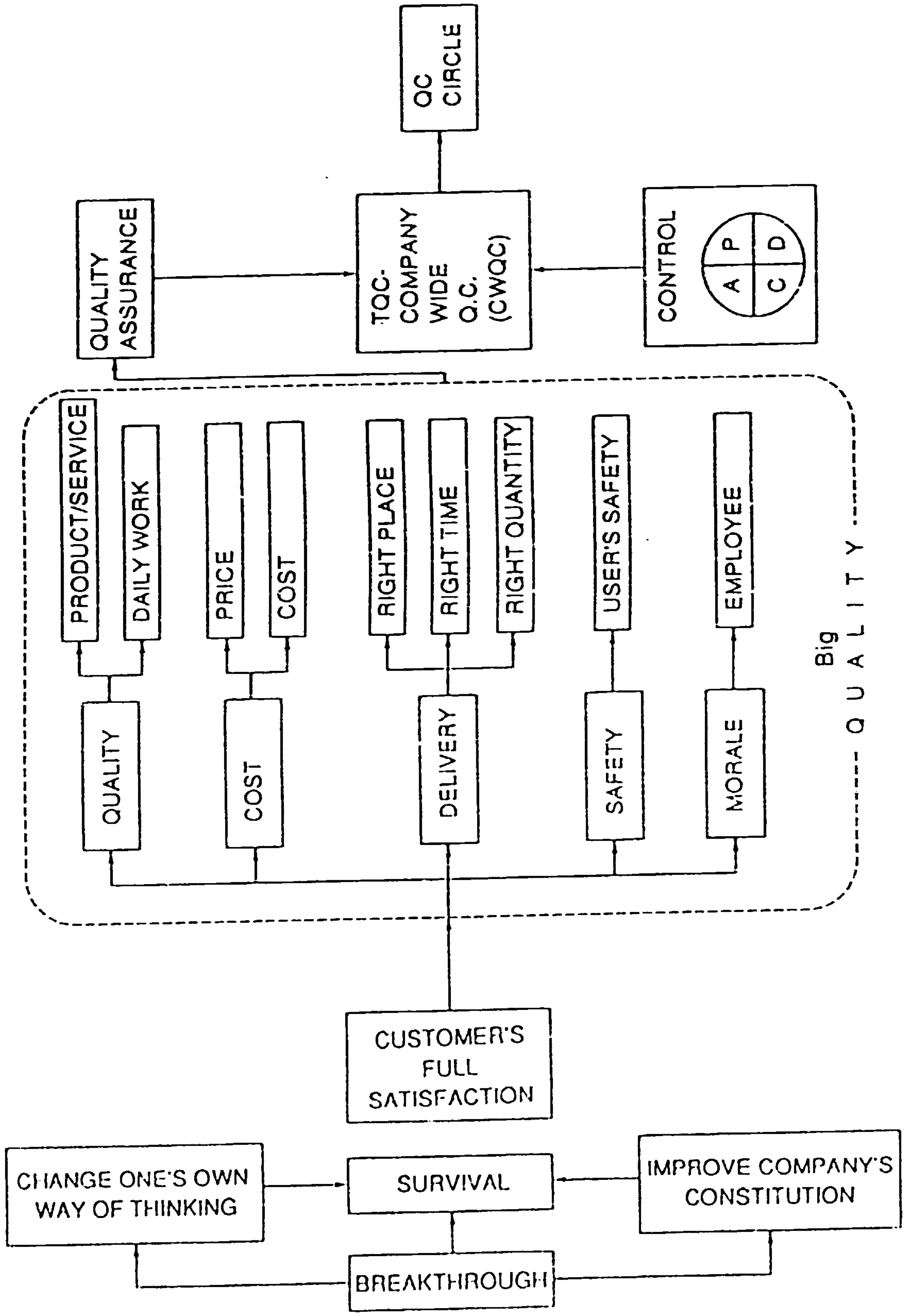


Fig. 1 Big "QUALITY"

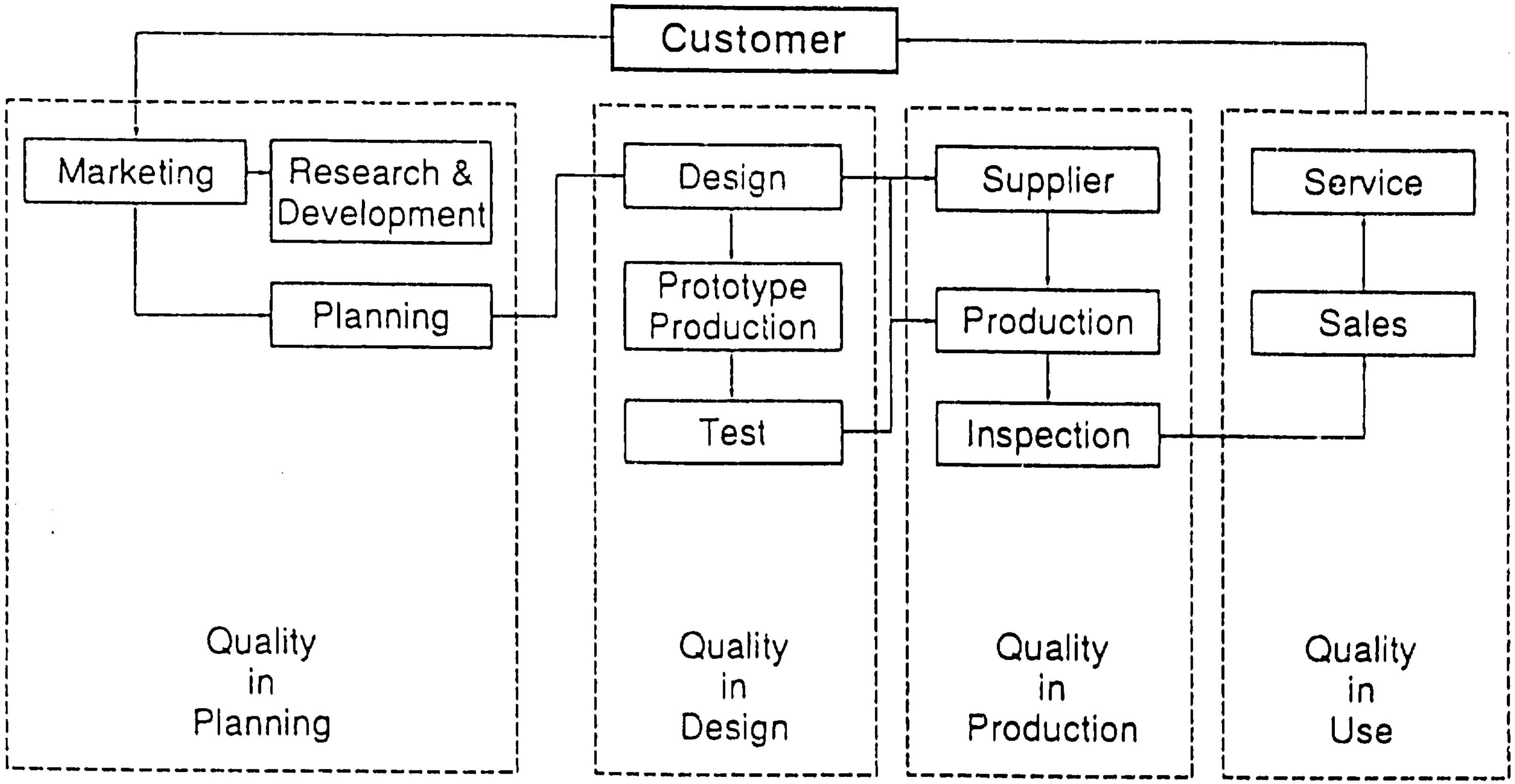


Fig. 2 Quality Assurance in Product Life Cycle

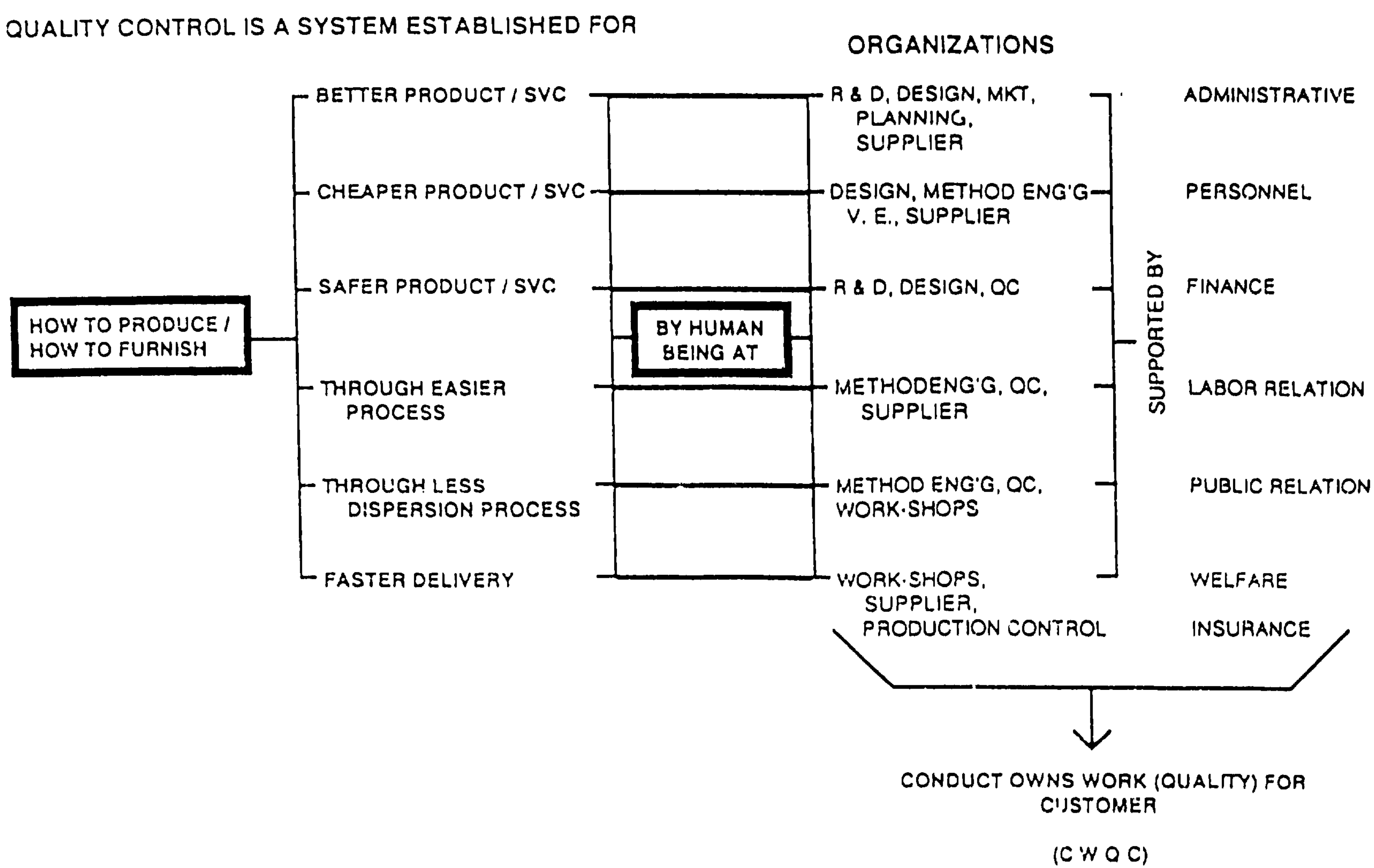


Fig. 3 Quality Control in CWQC/TQC

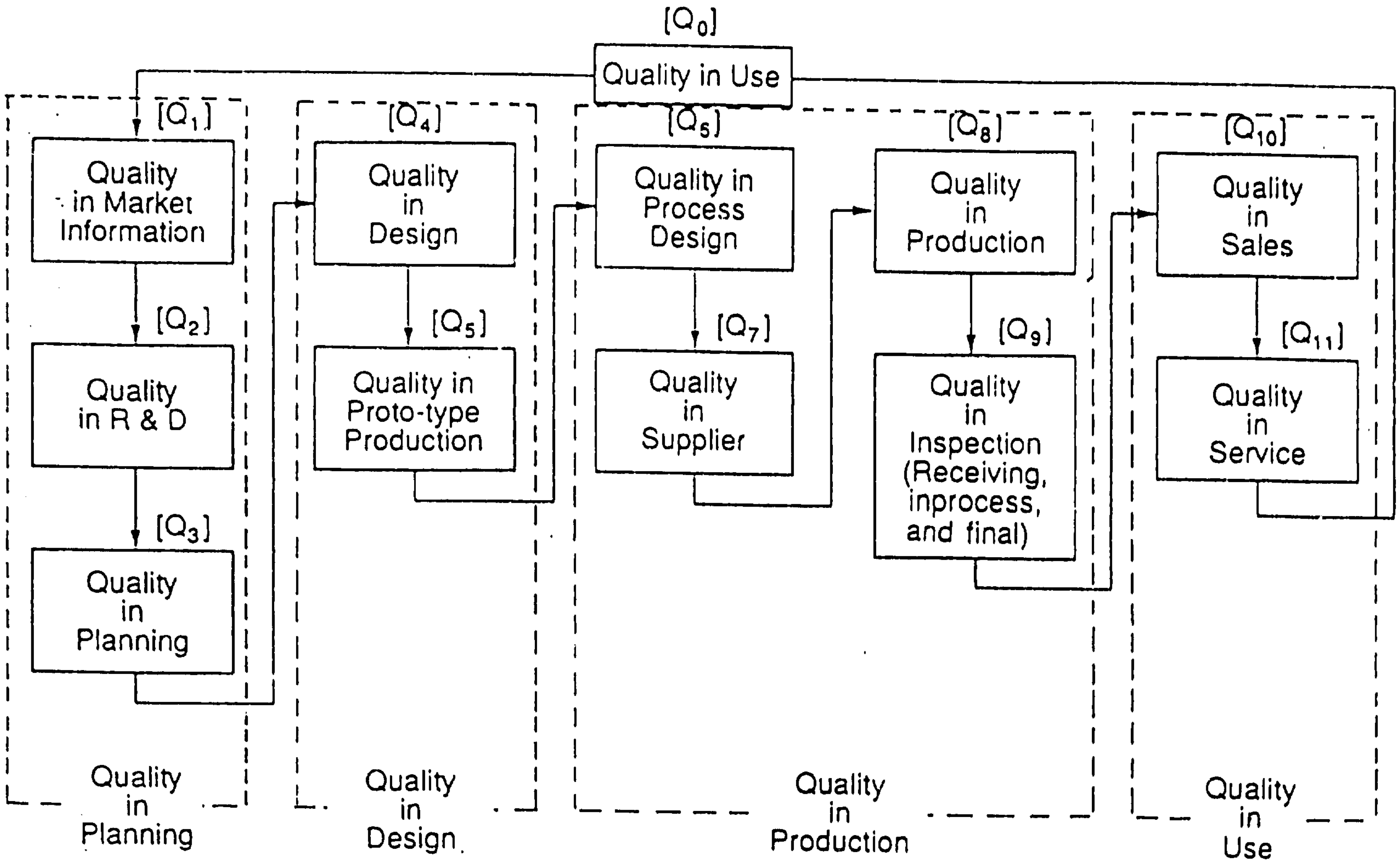


Fig. 8 Quality Classification in Product Life Cycle

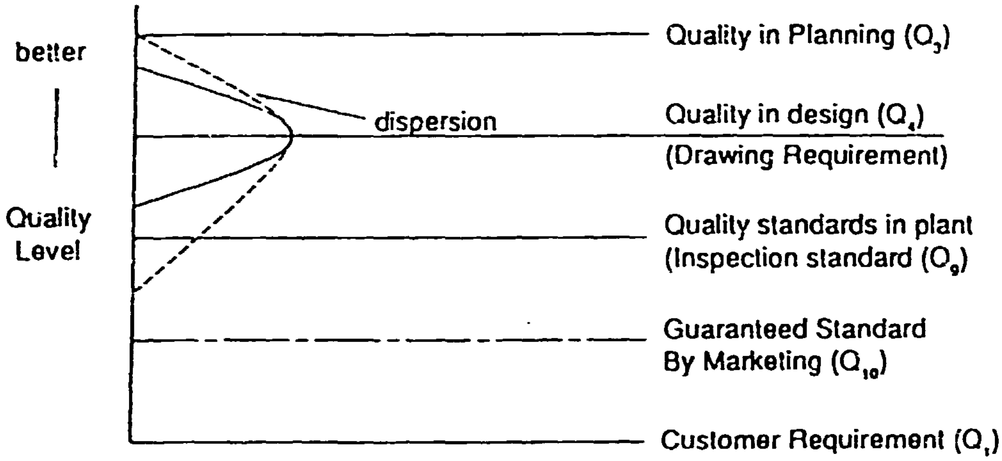


Fig. 4 Quality level in each phase

D) Difference between quality assurance and quality control

Quality assurance action is quite similar to climbing up to the top of hill which would be representing a level of quality requirement by customers. If a customer wants to reach the top of hill, he must climb up himself to enjoy the delightfulness of conquering the hill. Under the same token, if a customer wants to obtain a product (a certain level of quality which would be representing the height of a hill), instead of him, a producer must climb up the hill himself, and must declare to the customer the quality level demanded has been achieved by, which is sometimes called as inspection — quality assurance.
As shown in Fig. 5, 6 & 7.

A) Before the WWII

Before the WWII, customer requirements were not so high that hill-climbing or quality assurance of customer demands could be done by mere foot-climbing or inspection — visual and simple dimensional inspection.

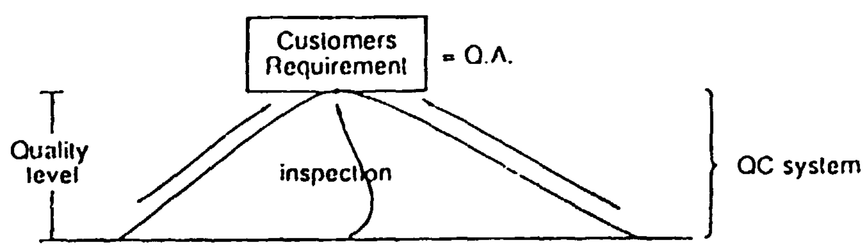


Fig. 5 Q.A. procedure before the WWII

The climbing could be conducted either by going up the sides of hills or direct climbing up on foot. As for quality assurance, direct product inspection is the only and surest method for customer requirement (Quality) assurance and inspection process is now called as quality control.

B) During the WWII

DOD had issued for quality control system and organization specifications MIL-Q-5923 and MIL-Q-985A for weapons quality, which specified quality had to be controlled by engineering (drawing & specifications), production (process control and finish product), and quality control (inspection system and organization) departments.

It was the dawn of the present QC concept that to climb the higher quality required hills, the DOD specifically requested the climber (manufacturer) to use mandatory MIL-SPC.

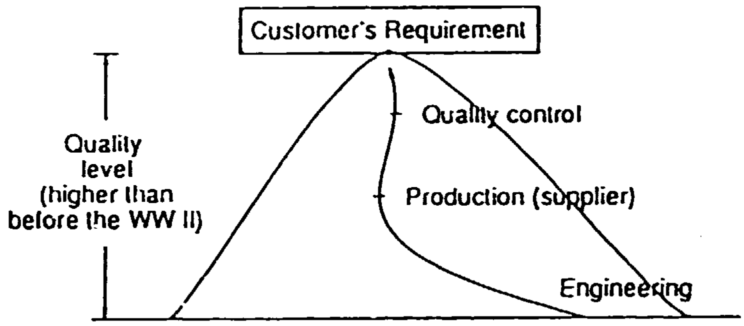


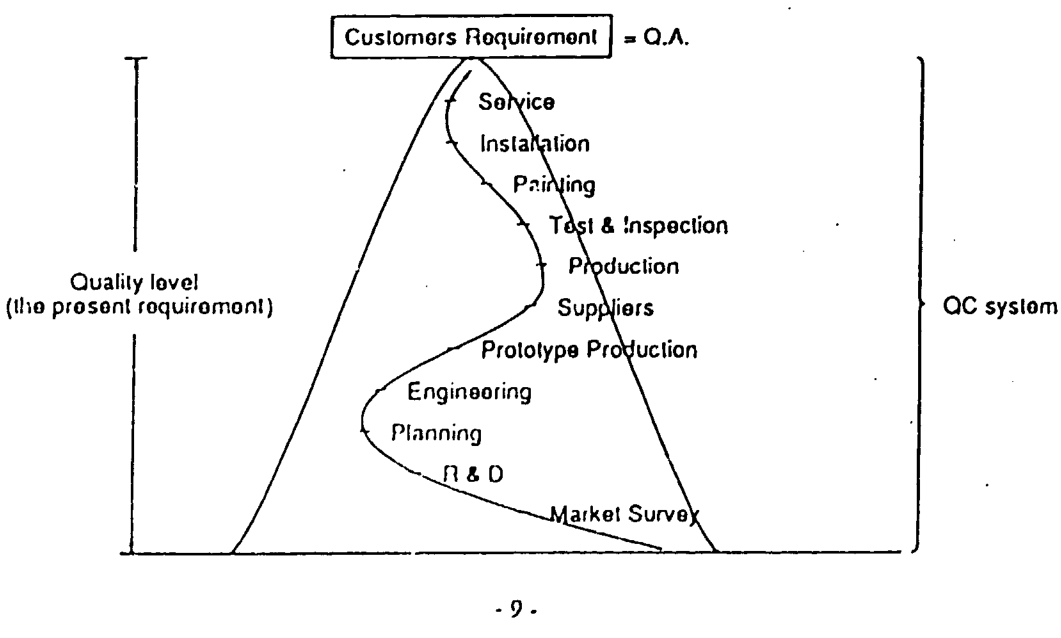
Fig. 6 Q.A. During the WWII

New concept of "climbing-gears" (3 independent departments were requested to establish system and organizations for customer satisfaction methodologies) quality control was has been implemented all through the WWII.

To assure customer requirement (control) assurance, only 3 major organizations were designated as the responsible organizations, and these assurance processes and procedures are called quality control.

C) After the WWII

Now, the customer requirements are sharply changed to the higher and higher quality year after year that the conventional quality control concepts became rather insufficient. As stated in the following Fig. 7, every department (not just 3 departments) is requested to participate from marketing to service to conform with customer requirements, depending on what responsibility is being imposed on their assignments.



Marketing – must conduct reliable market survey. The survey analysis is necessary to be really reflecting on real customers' demands for R & D and planning departments which are the quality assurance functions.

Production – must produce reliable and satisfiable products for the next downstream shop and finally the end-users, by conducting quality assurance activities which could be conducted with their own hands at own shop.

Accordingly, each department is requested,

to identify its own quality requirement

to establish quality procedures

to conduct or follow these procedures

to assure conformance,

these are the prime functions of quality assurance. What kind of actions are necessary to conduct to perform these functions such as "to identify its own quality requirement"?

This specific detailed action is "quality control". In other words, quality control is nothing but a detailed procedure for quality assurance execution.

4. Quality assurance for quality in Planning.

To assure the quality in planning, the following are necessary to cover,

4-1 / [Q_1] Quality in "Market Information"

Market information:

- Claim information & status
- Complaint information & status
- Warranty status
- Repairing status
- Spare-parts consuming status
- Reliability status
- Maintainability status
- Safety status
- Competitive product quality status
- Quality improvement planning

Market survey:

- Market demands (needs) indentification
- Customers trend analysis
- Consumers trend analysis
- Competitors status and trend analysis
- Market Survey, analysis, and summerization
- R & D needs identification
- R & D project establishment

4-2 / [Q_2] Quality in "Research and Development"

- R & D project decision and goal
- R & D project budget allocation
- R & D project manning allocation
- R & D project expedition & control

4-3 / [Q_3] Quality in "New Product Planning"

Quality level decision (performance, function, reliability, longevity, maintainability, and safety) new product specification establishment new technology integration decision test specification establishment new product development program decision new product demands forecasting comparison with competitive products estimation of market price of new product estimation of market flow estimation of new product demand decision of new product introduction in the market	For New product development
improvement of conventional products in performance, function, reliability, safety, and maintainability improvement of cost reduction improvement of productivity improvement of processing in production	For Conventional product

as shown in Fig. 8

5. Quality Assurance For Quality in Design

5-1 [Q_4] Quality in Design

[Q_4] Quality in design must be assured for the production stages, based on [Q_3] which are specified at planning stages. [Q_4] Quality in design are further broken-down as shown in Fig.9, till finalizing for mass-production drawings and specifications.

A) Broken-down design stages, as stated below

(1) conceptual design

(2) fundamental (system) design

(3) detail design

(4) trial (prototype) p. luction

(5) process-design

(6) pre-production

(7) mass-production drawing freezing

B) Assurance methodology

To assure [Q_4] Quality in design, the following stated assurance methodology are necessary to implement

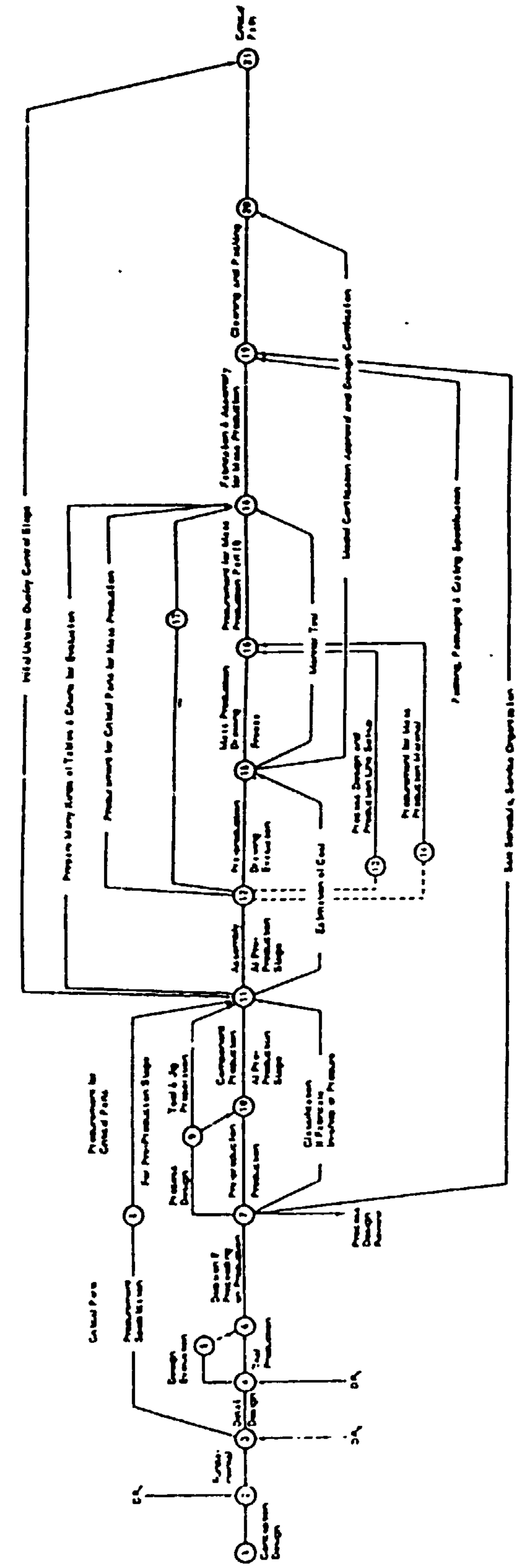


Fig. 9 New Product Design Flow & Its Quality Assurance (Example)

(1) Quality deployment
(2) Design review,
-Conceptual design review
-System (Intermediate) design review
-detail design review
(3) Trial (prototype) production and test
(4) Failure-Mode Effect analysis
(5) Fault Tree Analysis
(6) Reliability test
(7) Simulation test
(8) Endurance test (Life test)
(9) Acceleration test
(10) Hazard Analysis

5-1-1 Conceptual Design Quality Assurance.

At this stage, the following stated must clearly be identified for the next downstream stages,

(1) clear statement of customer's requirement

(2) conceptual design alternatives for choices/selections

(3) Identification of neck-engineering fields or weakness in design

(4) cost estimation

(5) scheduled program for commodity

(6) Competitors status and trends in similar product/services

(7) mock-up test evaluation

5-1-2 Fundamental (System) Design Assurance

(1) Full interpretation and understanding of mission (operational) requirement.

(2) Identification of conditions or environment of customer use

(3) Forecasting of reliability and maintainability indexes

(4) Fault tree analysis status

(5) Material and component tables

(6) System and subsystem configuration planning

(7) Life cycle cost estimation

(8) New product development master schedule

(9) System design specification

(10) Design concepts-Design Package

(11) Hazard analysis

5-1-3 Detail Design Assurance

(1) Design specification and standards and drawings

(2) Material specifications

(3) Component detail specification or standards

(4) FMEA status reports

(5) Test requirement

(6) Full scale drawings and specifications

(7) Electric line drawings

(8) Equipment full installation drawing

(9) Process standards

(10) Hazard analysis

5-2 [Q_5] Quality Assurance For Quality in Prototype Production

After drawing and specification are finished, the prototype production will begin to assure the drawing and specifications statements are confirming to the planning requirements and customers.

5-2-1 Trial (Proto-type) Production

(1) Conformity status of production schedule

(2) Conformity status of Budget

(3) Quality conformity status to specification & drawing requirement preparation schedules

(4) Compatibility with quality, time and cost relationship

(5) Producibility and inspectability evaluation

(6) Interchangeability and replaceability evaluation

(7) Maintainability and sustainability evaluation

(8) Test result report credibility

6. [Q_6] Quality assurance of "Quality in Production"

6-1 [Q_6] Quality assurance of Quality in process design

[Q_6] Quality in process design are necessary to assure for full conformance to the drawing and specification requirement, based on Quality function deployment analysis. To fully assure [Q_6] Quality in prosess design, the above mentioned methodology are necessary to keep in minds for inplemention as required depending on the situation observed.

A) Process design conformity status with established schedule

B) Debugging quality for acceptability in production (cross-die, machining tools, etc.)

C) FMEA status in process-design stages.

D) Producibility and inspectability checking status

E) Fool-proof implementation status (baka-yoke, or poka-yoke)

F) Number of standardization status (operation manual, inspection manual, etc.)

G) Quality function deployment

H) Process review function

6-1-1 Quality Assurance for Quality in Production Planning

Quality in production is the key function of money-making, profit generation and customer satisfaction that from the stand point of quality, thorough quality generating procedures are necessary to establish at production planning, which are

A) Decision to make or buy

B) Decision of new machine procurement, or modification

C) Selection of suitable supplier

D) Identification of process capability for equipment in-house and suppliers

E) Establishment of production quantity and production schedule

F) Establishment of manning table

G) Establishment of learning curve

6-1-2 Quality Assurance for Quality in Production Engineering

After engineering drawings are released to the production areas, production engineering is quite busy for pre-production preparation and preparing operation manuals for each processing to assure quality.

A) Layout preparation.

(1) Workshop distribution followed by operation sequences to assure effective use of floor spaces

(2) Equipment and machinery installation to assure material transportation and distribution effectiveness.

(3) Energy distribution schemes to assure energy conservation and productivity effectiveness.

B) Equipment / machinery investment

(1) Production system establishment – for continuous mass production line with some tact speeds, or group production system, etc. to assure productibility improvement, and profitability increase and energy conservation.

(2) Selection of equipment / machine at each workshop operations to assure quality, cost, time, quantity, and delivery for customers.

(3) Installation of new equipment & modification or modernization of machinery with prioritization to assume uniformed quality, production cost and delivery.

C) Establishment of standardized operation hours.

(1) Analysis of every process to asssure productivity and quality improvement.

(2) Work measurement of every operation by sequences to assure operator's effectiveness at each operations.

(3) Establishment of standardized operation hours to assure quality, time, delivery, and quantity, and cost.

(4) Improvement of working hours and productivity to assure reduction of working hours.

(5) Improvement of processing procedures to assure quality, time, quantity and cost effectiveness.

D) Equipment and machinery maintenance and calibration

(1) Establishment of preventive maintenance program, system and organization.

(2) Establishment of monitoring maintenance program, system and organization.

(3) Establishment of corrective maintenance program, system and organization.

(4) Establishment of operators manitenance program and system.

(5) Establishment of calibration control for every instruments installed on equipment and machinery.

(6) Establishment of maintenance data analysis system for maintenance concept improvement (for availability, reliability and maintainability).

(7) Establishment of SS concept implementation program and system.

(8) Establishment of good house-keeping audit system and its execution

to assure
- reduction of down time,
- improvement of logistic effectiveness
- increase of availability
- reduction of failure rate in production processings
- improvement of process quality
- motivation of not-stereo-typed works
- job creation
- challenge to statistical methodology utilization in workshop

6-2 Quality Assurance for Quality in Processes Operations

(1) Establishment of operation manual (standard operation procedures (SOP)).

(2) Furnishment of work instruction by supervisors.

(3) Preparation of necessary material, components, tools and jigs for operations by supervisors or production control personnel.

(4) Set-up for necessary operations by supervisor.

(5) Physical operation while following the SOPs, by operators.

(6) Self-autonomous checks by operators for what they have done.

(7) Self-examining and recording for their operation status by operators.

(8) Daily checks for machine, equipment, tool & jigs used daily before and after use by supervisors and operators.

to assure
- quality, quantity, time and product cost specified.
- reduction of failure in processing
- increase of productivity
- decrease of turn-over rate
- increase of availability
- reduction of down time
- increase satisfaction of downstream shops

7. Quality Assurance of "Quality in Supplier"

[Q_7] Quality in Supplier are basically as same as procedures implemented at Vendee company, and accordingly are requested and instructed to follow as mentioned in [Q_4], [Q_5], [Q_6], [Q_8] and [Q_9] successively.
In addition to the aboves, the followings are necessary to implement.

A) Supplier source selection.

(1) Reliable and accurate market survey to identify qualified suppliers to assure their capability for quality, quantity, and cost management, and top management's attitude toward quality

(2) Contracting status with other manufacturers for the similar products to assure their quality levels and production capability.

B) Suppliers contractability

(1) Quality reputation verification
(2) Products delivery assurance
(3) Cost minded awareness
(4) Standardization status
(5) New product development capability
(6) Shorter lead time for delivery

To assure quality, quantity, time and cost-wise trustworthiness

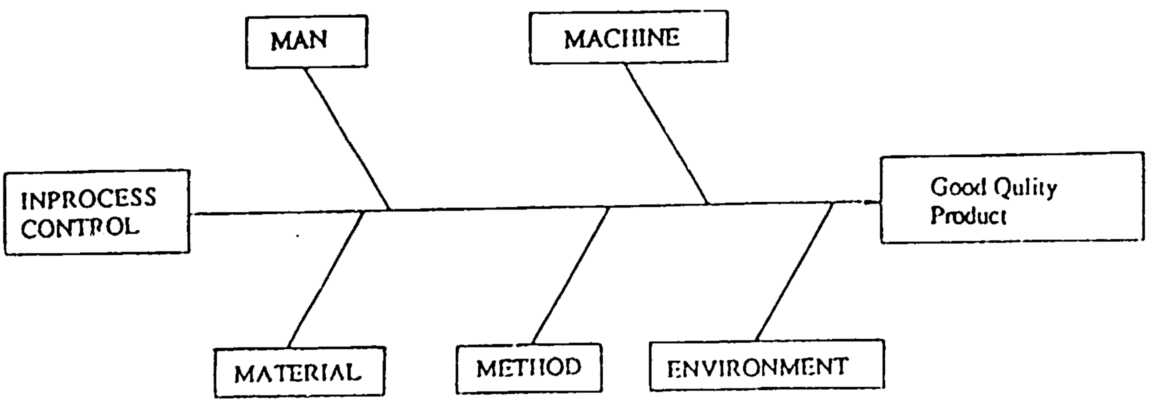
C) Contracting or purchase ordering

(1) Establishment of supplier procurement policy by top management
(2) Establishment of procurement cost evaluation policy and goals
(3) Establishment of supplier support for management, quantity and leadtime
(4) Establishment of financial support policy.

To assure for suppliers supporting policy implementation under group-wide quality concept

8. [Q_8] Quality Assurance of Quality in Production

The basic principle for [Q_8] quality assurance in production is not just to sort out failured product among finished product, but how good quality be integrated into the finished product during each processing operations. For that, it is very important to organize "good in-processes" which are explained in the precedent chapters how to prepared by every related organizations.



The above fish-bone chart will explain that to have good quality procedues are solely dependnig on Man, Machine, Material, Method, and Environment.

8-1 Preproduction Quality Assurance.

After verifying the prototype product quality, standard operation procedure (SOP) will be prepared for mass-production by using tool, jigs, and dies for mass-production. However, it is the first time to use such kinds of equipment that prior to use them, some sorts of debugging process will be in need, and this process are called as preproduction stage.

A) Preproduction schedule conformity status with established schedule

B) Debugging quality for acceptability in mass-production

C) Investigation of productivity improvement

D) Continuous FMEA status

E) Thorough analysis of standards established for feasibility

8-2 Inprocess Quality Assurance.

This is the final stage in production area for quality assuring operation, which is the most important function operated by operators (man). Lest of machine, material, methods and environment could be strictly controllable by management or supervisors, however the main factor, operators are far difficult to maintain as same as conditions physically and metally.
Under such circumstances, quite wide-range of quality assurance procedures are necessary to prevent from any dispersion cauused by operators.

A) Verification of production status by daily, weekly or monthly-basis to assure status of quality, quantity, and production-cost.
B) Identification of in-process inventory status to assure inventory status at inprocessing warehouse.
C) Identification of learning status to assure operators' skill improvement and production stastus control.
D) Identification of quality failure status to assure what kinds of preventive and remedial corrective actions are necessary to take.
E) Clarification of productivity delinquency status to assure for corrective action of yield ratio or productivity improvement.
F) Evaluation of Education and training status for recurrent problem obsevations.
G) Shop safety status improvement
H) Good housekeeping status improvement
I) Suggestion proposal status evaluations.

9 [Q_9] Quality Assurance of "quality in inspection"

[Q_9] "Quality in inspection" are practically included in [Q_7]- for suppliers' quality, [Q_8]-for inprocess and final inspection quality.
However, in case of specific inspection operation are performing by professional inspectors, [Q_9] quality assurance are necessary to define and control for their responsibility.
A) Establishment of standardization for various inspection method.
B) Establishment of clear test and inspection criteria in written forms.
C) Development of specific education and training conforning to the innovated test or inspection equipment or apparatus.
D) Correlation procedures to assure with inspectors consistency and accuracy and precision between inspectors.
E) Independency of PPM (PPB) level quality assurance technology.
F) Retrieval system of Quality informations.

10. [Q_{10}] Quality Assurance of "Quality in sales"

After much-efforted products finished by production operators, the sales function have much heavy dutied responsibility to deliver to the customer not only in domestic, but in international markets. Accordingly, their quality assurance [Q_{10}] are necessary to be functioned well enough.

10-1 Delivery and Shipping

A) Establishment of transportation method to assure product quality during transporting, storing and delivery and cost saving.

B) Establishment of just-in-time delivery program to assure customer satisfaction for in ventory control and distribution cost saving.

C) Establishment of adequate packing and packaging procedure to assure product quality.

10-2 Sales

A) Establishment of sales organization to assure effective sales-promotion activity

B) Establishment of punctual delivery system to assure customers full satisfaction.

C) Establishment of credit control system to assure funds rotation control.

10-3 Sales promotion

(1) Establishment of new customer searching system and organization to assure sales promotion.

(2) Establishment of new demands research system and organization

(3) Establishment of effective advertisement and public relation system and organization to assure the effective investment.

(4) Establishment of effective customers information collection system and department jointly organized with quality control department to assure the evaluation of product quality reputation and quality level in the market for quality, cost, and availability.

11. [Q_{11}] Quality Assurance of "Quality in service"

[Q_{11}] Quality in service are physically consisted of the kinds of Quality as stated in the followings in Fig.6.

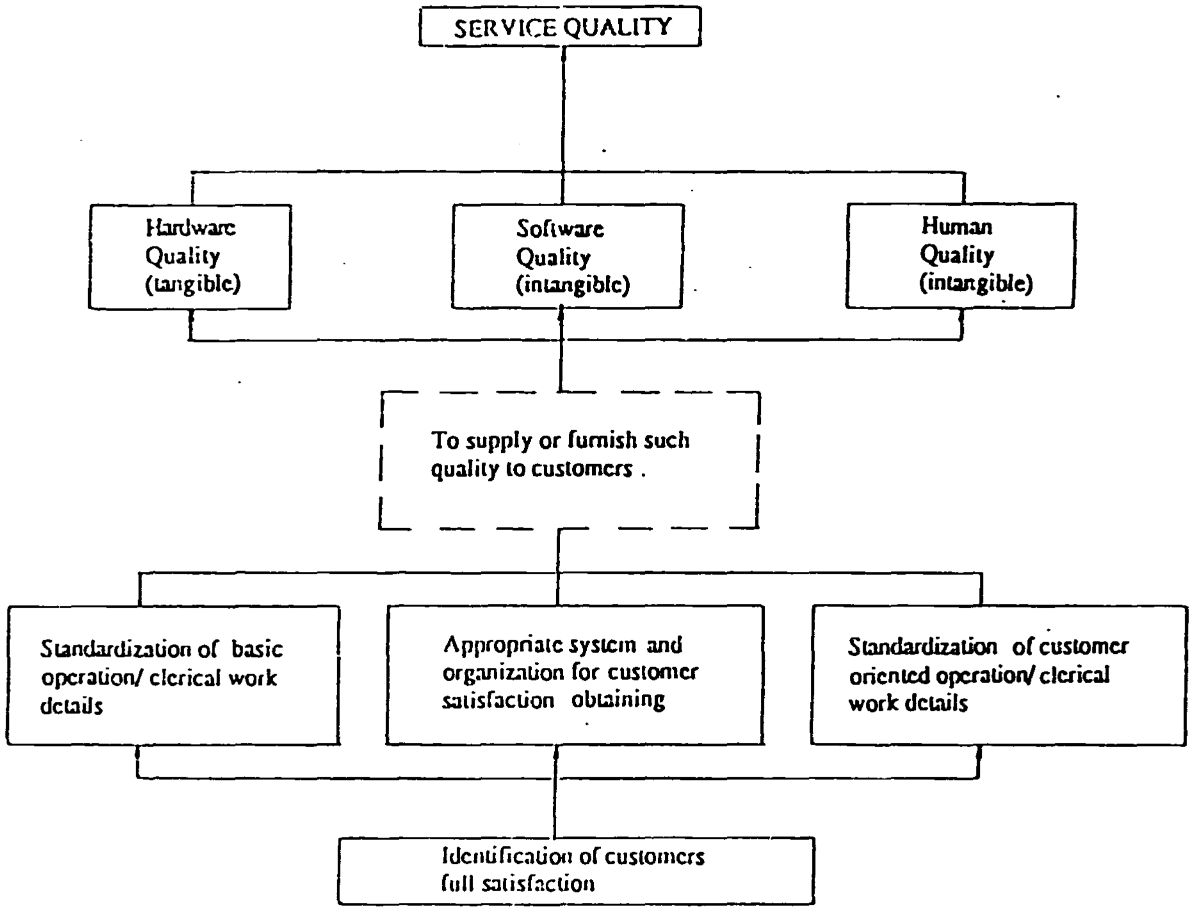
$$\left.\begin{array}{l}\text{Hardware quality}\\ \text{Software quality}\\ \text{Human quality}\end{array}\right\}\ \text{which are shoun at next page.}$$

A) As for production industry concerns, hardware and software qualities are more emphasized for customer satisfaction, instead, so-called service-industries concerns, much more of human and software qualities are high-lighted for customer than hardware and software qualities.

However, as for quality assurance concept, there are not have any distinctive differences between production and service industries to assune quality for customer.

For instances, restaurant has many hardware-such as cooking utilities, room, building, knife, fork — hardware without these quality, customer would not be appreciate their service, under the same token, a product service can't be satisfied by customer unless furnishing software quality — service manual, repair instruction, etc human quality— service mechanics behavior, product support men's skill and experience.

Accodingly, hardware, software and human quality in Service quality [Q_{11}] would be necessary to consider by the following stated ideas.


SERVICE QUALITY
Hardware Quality (tangible)
Software Quality (intangible)
Human Quality (intangible)
To supply or furnish such quality to customers .
Standardization of basic operation/ clerical work details
Appropriate system and organization for customer satisfaction obtaining
Standardization of customer oriented operation/ clerical work details
Identification of customers full satisfaction

11.1 Hardware Quality Assurance

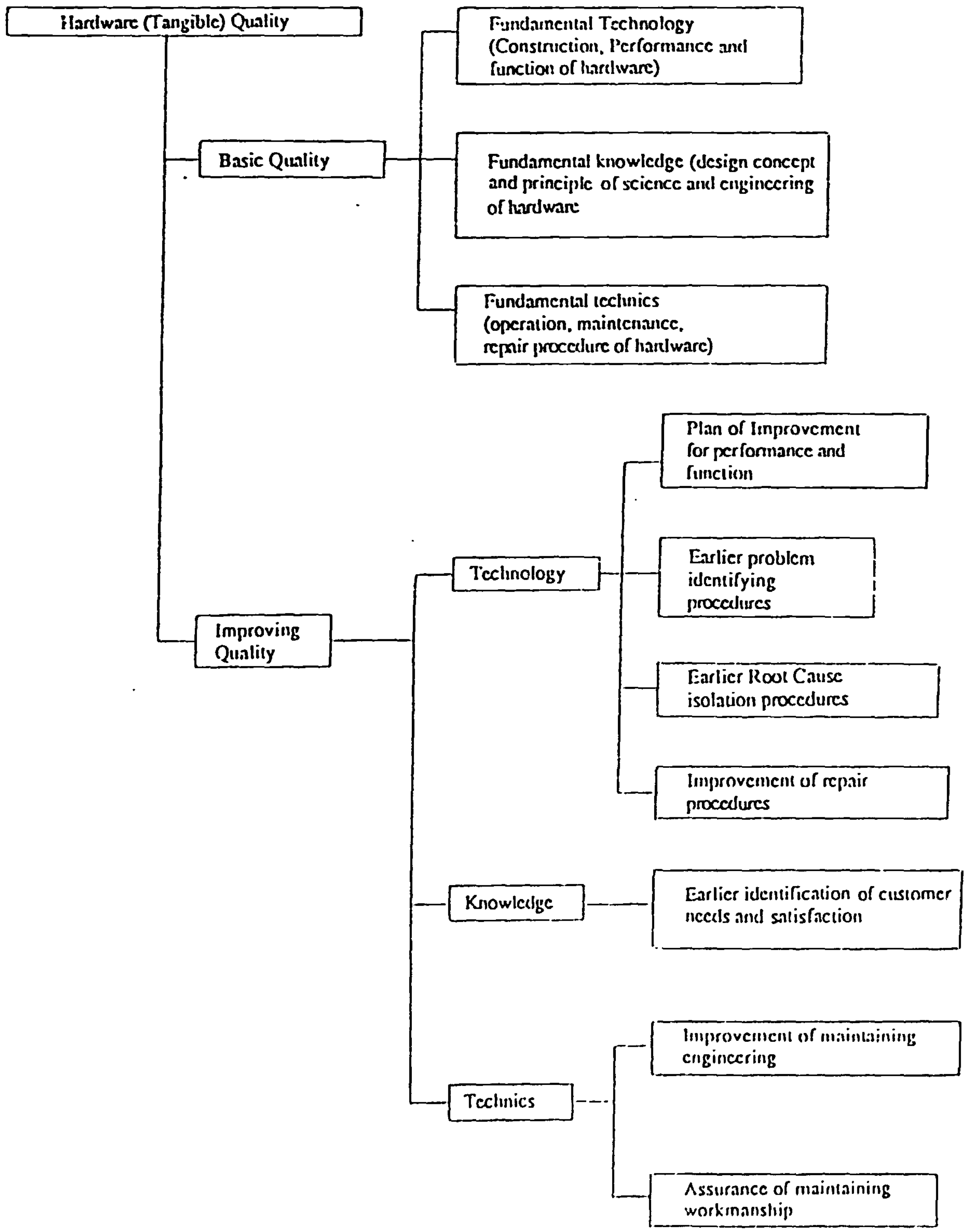


Fig. 7 Hardware Quality

11.2 Software Quality Assurance

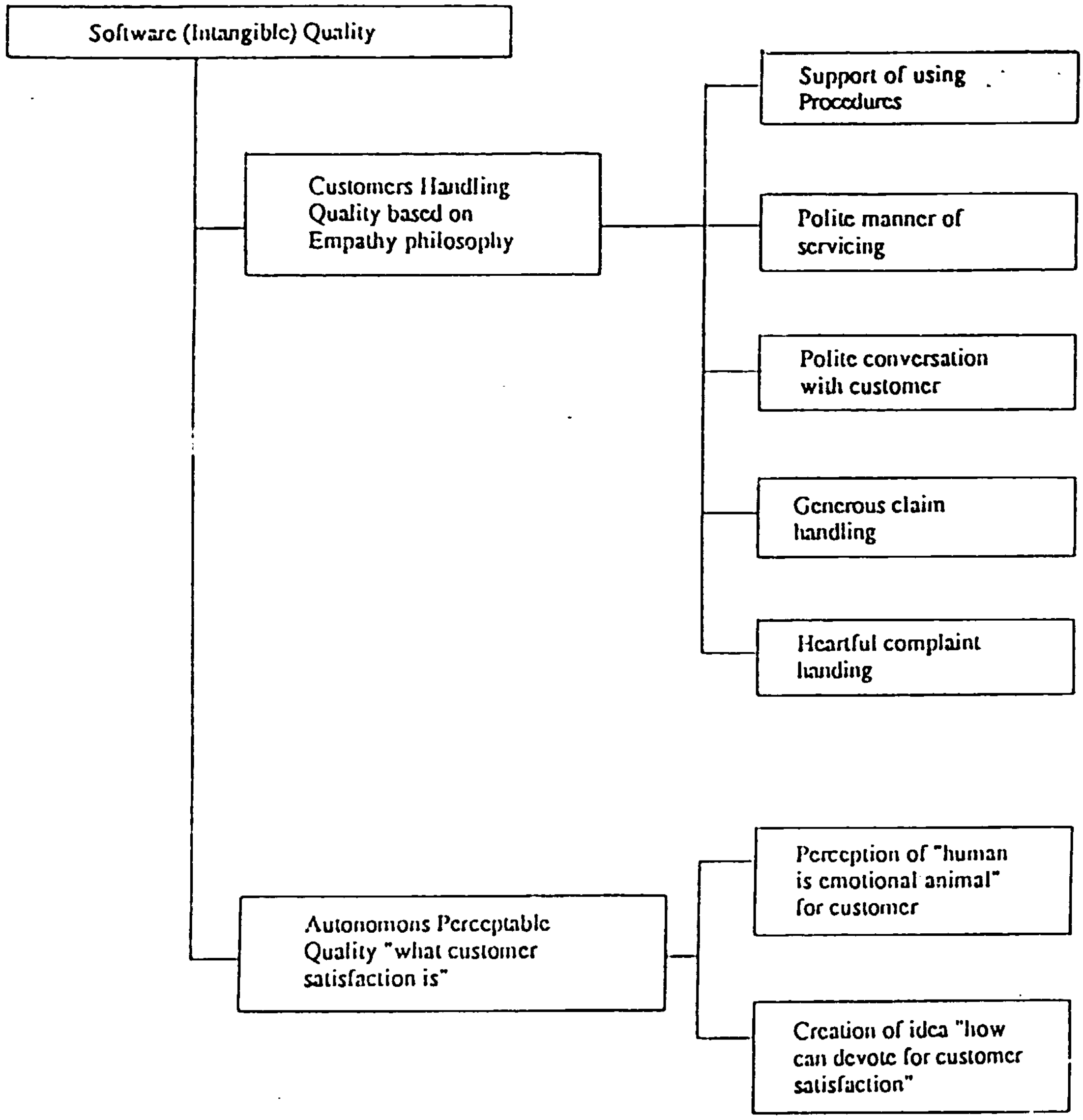


Fig. 8 Software Quality

11.3 Human (intangible) Quality Assurance

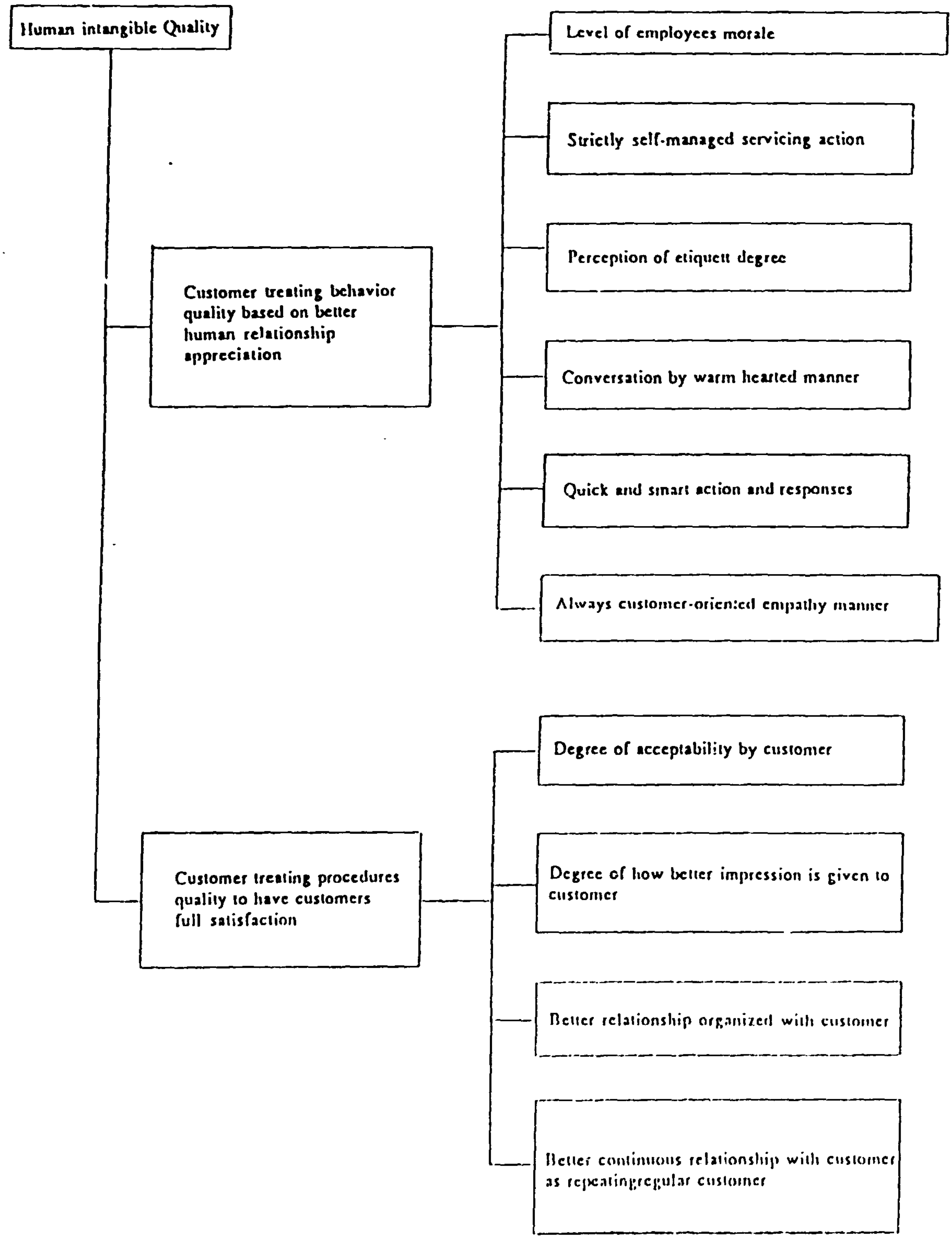


Fig. 9 Human Quality

12. Relationship with QA_{Jpn} and ISO 9000 series

A) ISO 9000 Series

- ISO 9000
  - Contractual Quality Assurance Standards
    - ISO 900 : To Ensure Conformance To Specified Requirements During Design, Development, Production, Installation, and Servicing
    - ISO 9002 : To Ensure When Only Production and Installation Conformance
    - ISO 9003 : To Ensure Only Conformance In Final Test & Inspection
  - Internal Use Only, and is not to be used in Contractual Situations
    - ISO 9004 : Contains Guidance On The Technical, Administrative, and Human Factors Affecting The Product/ Service Quality, Which Listing The Essential Elements-Such as Establishing A Quality Systemfolr Marketing, Design, Procurement, Production, Measurement, Post Production, Material Control, Documentaition, Safety, and Use of Statiscal Method.

B) Some comments by experts

1-1 Presupposition of ISO 9000 Series implementation

By Mr, Yves Van Nuland, Quality manager of UCB Chemical Sector in Brussel, Belgiem, (QP, June 1990, P41) recommended.

The practice of ISO 9000 in each company will be successful only when two conditions are met;

1. Total quality control must already be present or be introduction at same time as ISO 9000.
2. Management must overwhelmingly commit to quality.

1-2 Future of ISO 9000 series

By MR.Joseph J. Klock, the quality and reliability planning manager at AT&T, in Union, N. J, (QP, June 1990, p47), warned
"The ISO 9000 series sets minimum criteria for AT&T suppliers. Future programs will use Malcolm Baldridge National Quality Award criteria to reach even higher standards of excellence.

C) Comparison Between ISO 9000-Series and D-Prize and B-Award

According to Mr. Johnt Burr, (p23, QP, June 1990,)

1. ISO 9000 series are more generic and represent the minimum requirements, (only) to meet customer requirements

2. B-Award, and D-prize criteria for competition are require more greater
   -planning,
   -management
   -implementation focused on results of using the quality system

3. For Supplier, it covers regardless of-industry bases
   -company size

4. Do not tell a company how to document the quality system
   -what is a quality manual?
   -what is a quality plan?
   -what makes up an adequate quality policy?
   -who should be responsible?
   -what is authority?

5. Don't mention or make a provision for continuous improvement.- Dr. J. M. Juran points out until addressing in the future, (1) continuous improvement, to lower cost, to improve product and service quality, (2) to remain competitive in today's world economy.

6. Not requires no evidence of a satisfactory task records of performance in product quality or delivery.
(Because, will usually be identified as a part of a purchase contract.)

13. Comparison of Concepts for Deming Prize & Baldridge Awards

	Deming Prize	Baldrige Award
Purpose	To Award Prize To Those Companies Which Are Reiognized As Having Successfully Applied CWQC Based on Statiscal Quality Control and Which Are Likely To Keep Up In The Future.	To Promote Quality Awareness, RecogNize Quality Achievements Of U.S.Companies, And To Poblicize Successful Quality Strategies.
Judging Criteria	1 Page Checklist	23 Page Checklist
Emphasis Statistical Method	More Statistical Methods Are Necessary To Consistently Use Throughout All Aspect.	Overall Importantce
Recipient	Every Company Over A Minimum Standards More Than 70 POINTS (rating)	Max. Of 2 awards Per Category Per Year
Timeline	A Year	About 6 Months
Tupe Of Award	A Recognition	An Element Of Competition
Emphasis	More Inprocessing Oriented	More Result Oriented

14. Quality Assurance Concept Implementation

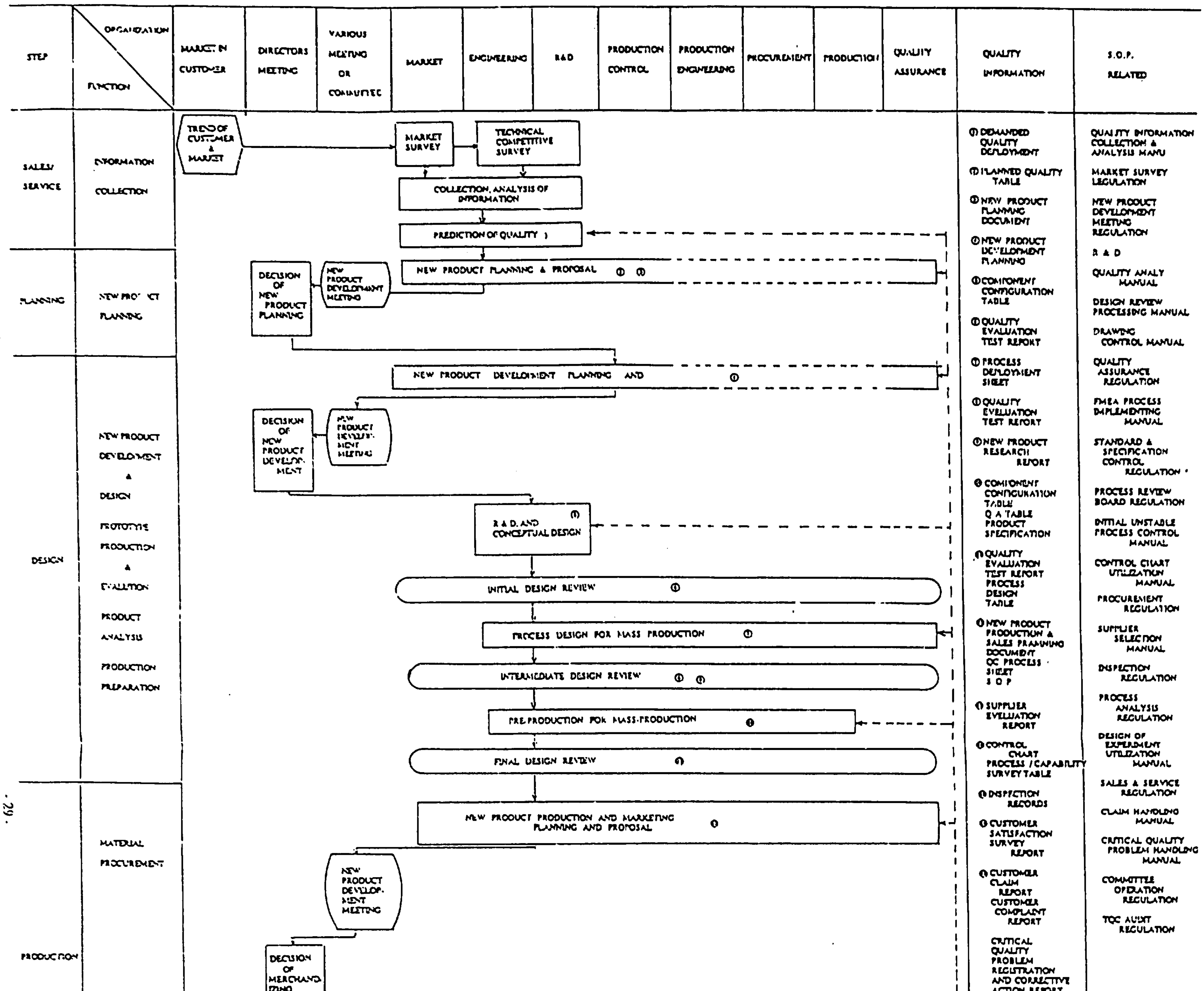
Japanese quality assurance concept under TQC are differing from each other companies as mentioned before, that here's enclosed some examples how they are organize and functioned, as shown in Fig. 10 and 11.

15. Future Quality Assurance to be considered

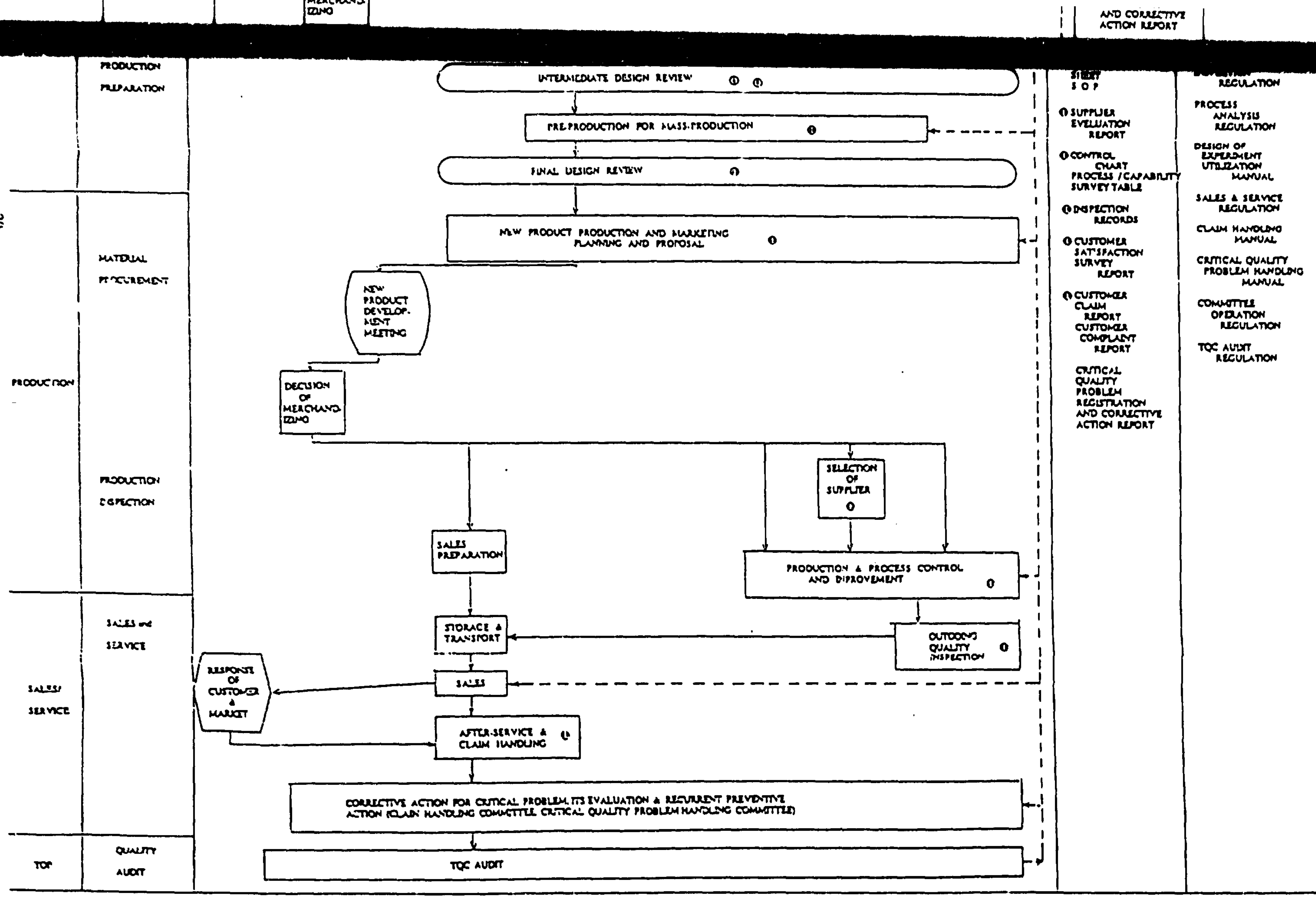
A) Establishment of innovated quality assurance system.
B) Sustaining of Particle per million (PPM) level of quality at customers hands or better.
C) Development of new product quality assurance methodelogy.
D) Development of design quality assurance.
E) Sustaining of particle per billion (PPB or PPT) level of quality at in-processing stages.
F) Progress of fool-proof methodology in inprocessing stages.
G) Development of feasible operation and maintenance manual.
H) Development of innovated diagnosis methodology for maintenance and repair.
I) Development of automated diagnosis equipment or test apparatus.
J) Development of quality information system.
K) Development of quality assurance for software.
L) Development of life-cycle cost assurance system and proceeduces.
M) Shortening of new product development time cycl.
N) Expedition of production time cycle.

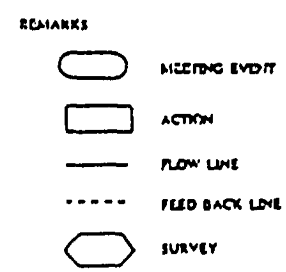
O) Collaboration of suppliers.
P) Improvement of daily routine work control.
Q) Motivation of improvement awareness.
R) Collaboration of international or grobal industrialization.

SECTION 1


STEP
ORGANIZATION
FUNCTION
MARKET IN CUSTOMER
DIRECTORS MEETING
VARIOUS MEETING OR COMMITTEE
MARKET
ENGINEERING
R&D
PRODUCTION CONTROL
PRODUCTION ENGINEERING
PROCUREMENT
PRODUCTION
QUALITY ASSURANCE
QUALITY INFORMATION
S.O.P. RELATED
SALES/ SERVICE
INFORMATION COLLECTION
PLANNING
NEW PRODUCT PLANNING
DESIGN
NEW PRODUCT DEVELOPMENT & DESIGN
PROTOTYPE PRODUCTION & EVALUATION
PRODUCT ANALYSIS
PRODUCTION PREPARATION
MATERIAL PROCUREMENT
PRODUCTION
TREND OF CUSTOMER & MARKET
MARKET SURVEY
TECHNICAL COMPETITIVE SURVEY
COLLECTION, ANALYSIS OF INFORMATION
PREDICTION OF QUALITY)
NEW PRODUCT PLANNING & PROPOSAL
DECISION OF NEW PRODUCT PLANNING
NEW PRODUCT DEVELOPMENT MEETING
NEW PRODUCT DEVELOPMENT PLANNING AND
DECISION OF NEW PRODUCT DEVELOPMENT
NEW PRODUCT DEVELOPMENT MEETING
R & D. AND CONCEPTUAL DESIGN
INITIAL DESIGN REVIEW
PROCESS DESIGN FOR MASS PRODUCTION
INTERMEDIATE DESIGN REVIEW
PRE-PRODUCTION FOR MASS-PRODUCTION
FINAL DESIGN REVIEW
NEW PRODUCT PRODUCTION AND MARKETING PLANNING AND PROPOSAL
NEW PRODUCT DEVELOPMENT MEETING
DECISION OF MERCHANDIZING
DEMANDED QUALITY DEPLOYMENT
PLANNED QUALITY TABLE
NEW PRODUCT PLANNING DOCUMENT
NEW PRODUCT DEVELOPMENT PLANNING
COMPONENT CONFIGURATION TABLE
QUALITY EVALUATION TEST REPORT
PROCESS DEPLOYMENT SHEET
QUALITY EVALUATION TEST REPORT
NEW PRODUCT RESEARCH REPORT
COMPONENT CONFIGURATION TABLE
Q A TABLE
PRODUCT SPECIFICATION
QUALITY EVALUATION TEST REPORT
PROCESS DESIGN TABLE
NEW PRODUCT PRODUCTION & SALES PRAMNING DOCUMENT
QC PROCESS SHEET
S O P
SUPPLIER EVALUATION REPORT
CONTROL CHART
PROCESS /CAPABILITY SURVEY TABLE
INSPECTION RECORDS
CUSTOMER SATISFACTION SURVEY REPORT
CUSTOMER CLAIM REPORT
CUSTOMER COMPLAINT REPORT
CRITICAL QUALITY PROBLEM REGISTRATION AND CORRECTIVE ACTION REPORT
QUALITY INFORMATION COLLECTION & ANALYSIS MANU
MARKET SURVEY REGULATION
NEW PRODUCT DEVELOPMENT MEETING REGULATION
R & D
QUALITY ANALY MANUAL
DESIGN REVIEW PROCESSING MANUAL
DRAWING CONTROL MANUAL
QUALITY ASSURANCE REGULATION
FMEA PROCESS IMPLEMENTING MANUAL
STANDARD & SPECIFICATION CONTROL REGULATION
PROCESS REVIEW BOARD REGULATION
INITIAL UNSTABLE PROCESS CONTROL MANUAL
CONTROL CHART UTILIZATION MANUAL
PROCUREMENT REGULATION
SUPPLIER SELECTION MANUAL
INSPECTION REGULATION
PROCESS ANALYSIS REGULATION
DESIGN OF EXPERIMENT UTILIZATION MANUAL
SALES & SERVICE REGULATION
CLAIM HANDLING MANUAL
CRITICAL QUALITY PROBLEM HANDLING MANUAL
COMMITTEE OPERATION REGULATION
TQC AUDIT REGULATION

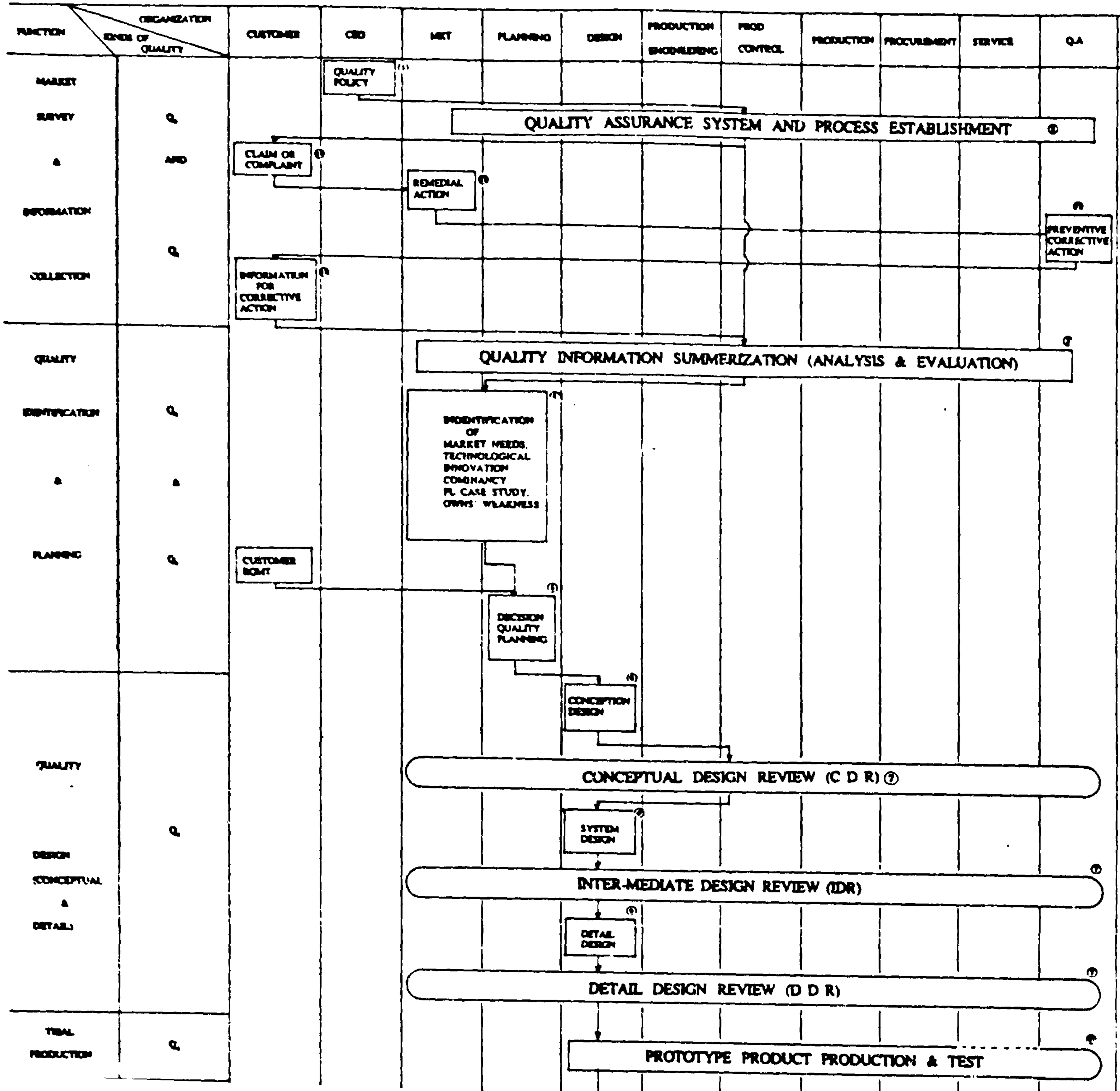
SECTION 2





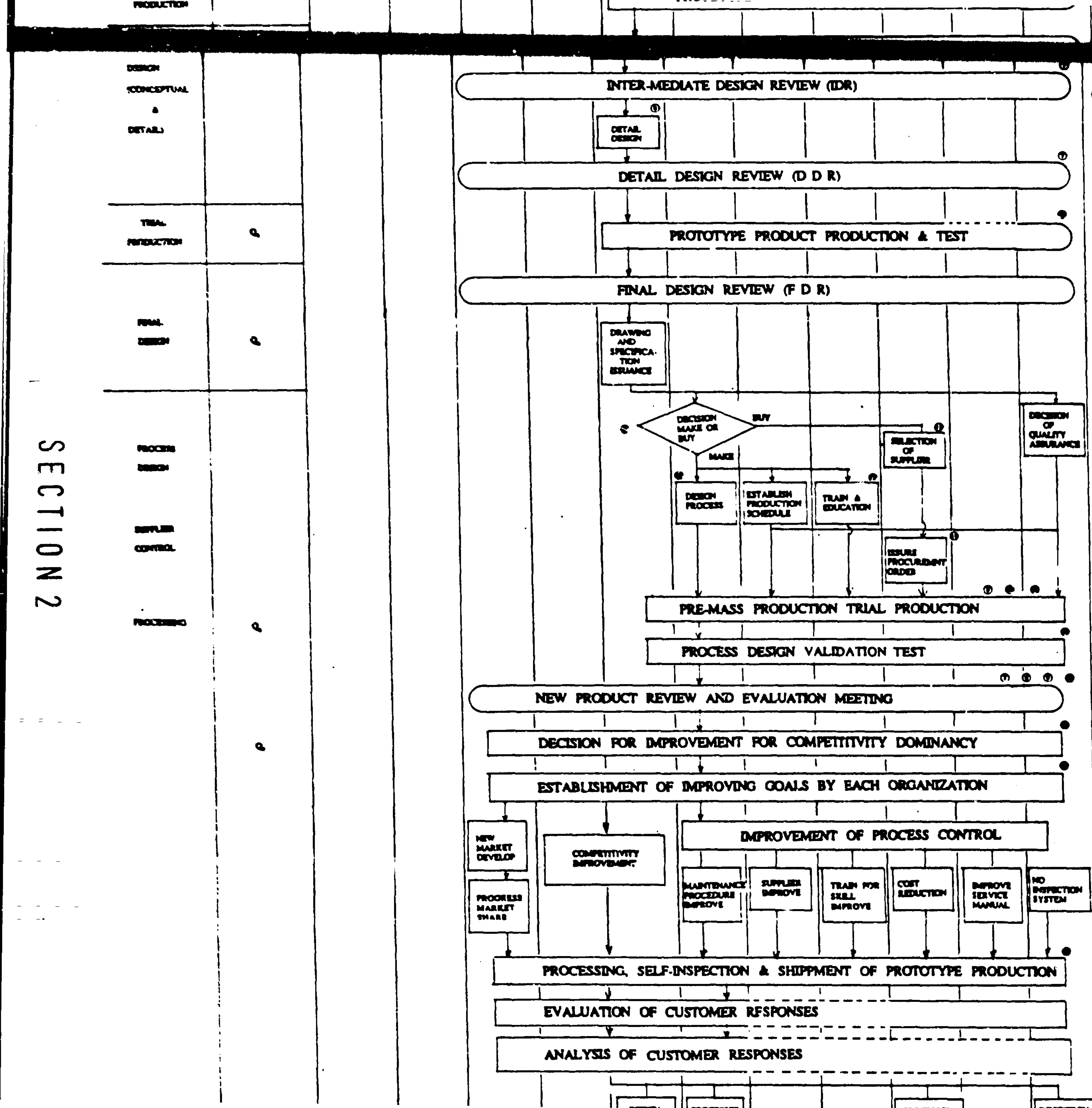
Fig, 11. QUALITY ASSU..ANCE FLOW CHART
(EXAMPLE)-NO.1

SECTION 1



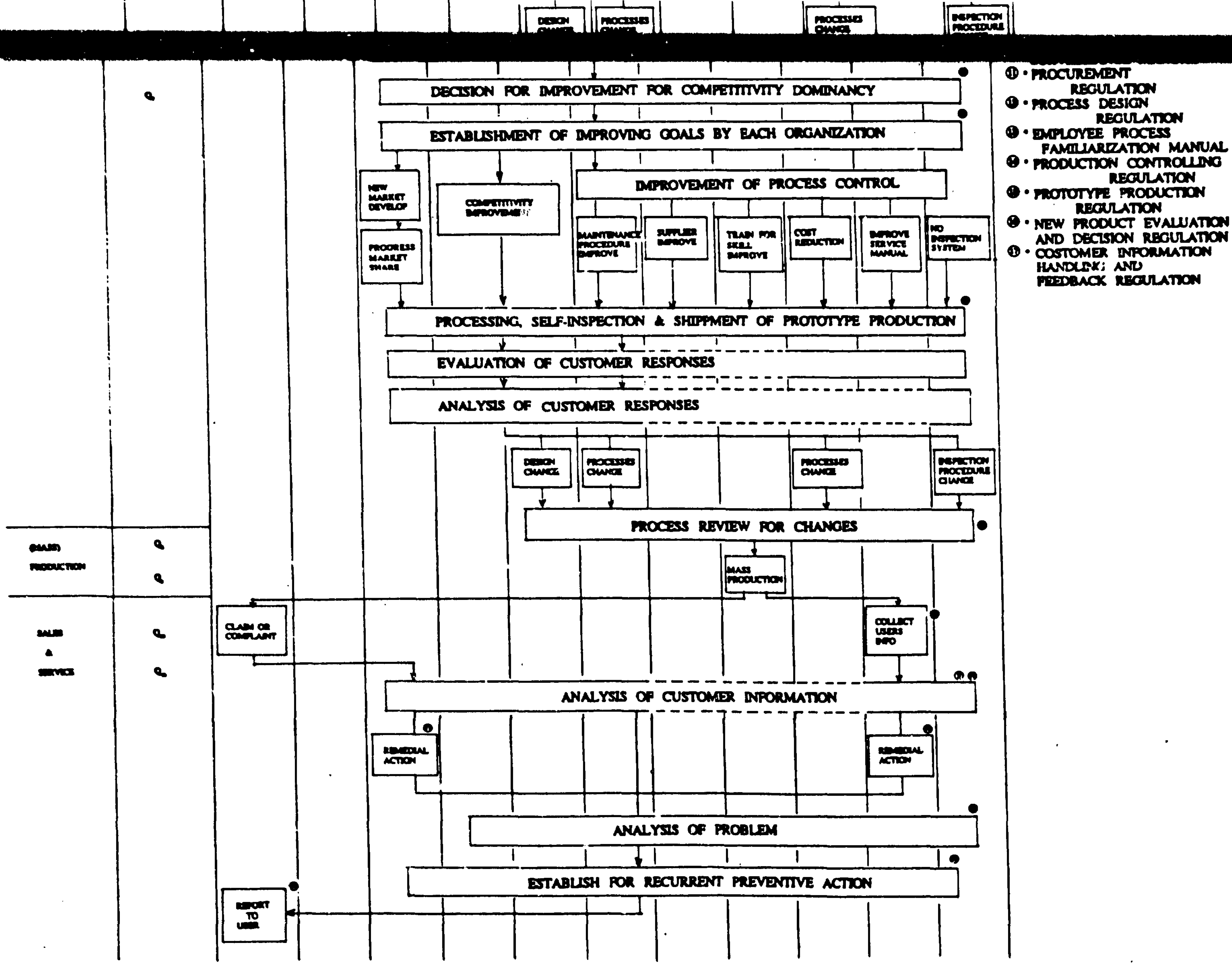
NECESSARY DOCUMENTATION AND METHODOLOGY

① TOP MANAGEMENT COMMITMENT
② QUALITY POLICY AND SYSTEM REGULATION
③ QUALITY INFORMATION–CUSTOMER, PLANNING, ENGINEERING, PRODUCTION, SUPPLIER, CUSTOMER SERVICE –COLLECTION, ANALYSIS AND EVELUATION MANUAL
④ • MARKET SURVEY AND RESEARCH REGULATION
• TECHNOLOGY INNOVATION RESEARCH REGULATION
• QUALITY DEPLOYMENT IMPLEMENTATION MANUAL
• PL CASE STUYING, TEAM ESTABLISHING MANUAL
• PL CASE REPORTING MANUAL
• COMPETITORS PRODUCT & PROCESS RESERACH
• RELIABILITY ANALYSIS MANUAL
• LOGISTIC ANALYSIS MANUAL
⑤ • RELIABILITY PREDICTION & ALLOCATION MANUAL
• MAINTAINABILITY PREDICTION & ALLOCATION MANUAL
• QUALITY DECISION REGULATION
• LIFE CYCLE COST PREDICTION AND ALLOCATION MANUAL
⑥ • QUALITY DEPLOYMENT MANUAL
• RELIABILITY & MAINTAINABILITY ENGINEERING MANUAL
• SYSTEM ANALYSIS MANUAL
⑦ • DESIGN REVIEW REGULATION
• DESIGN PACKAGE MANUAL
• DESIGN REVIEW BOARD MANUAL
⑧ • SIMULATION TEST MANUAL
• NEW TECHNOLOGY IMPLEMENT VALIDATION TEST MANUAL
• NEW COMPONENT RELIABILITY TEST MANUAL
⑨ SIMULATION TEST MANUAL.
• COMPONENT RELIABILITY TEST MANUAL



SECTION 2

TEST MANUAL
• COMPONENT SAFETY
TEST MANUAL
• DESIGN REVIEW BOARD
MANUAL
(8) • SIMULATION TEST
MANUAL
• NEW TECHNOLOGY
IMPLEMENT VALIDATION
TEST MANUAL
• NEW COMPONENT
RELIABILITY TEST
MANUAL
(9) SIMULATION TEST
MANUAL
• COMPONENT RELIABILITY
TEST MANUAL
• COMPONENT SAFETY
TEST MANUAL
• COMPONENT COMPATIBILITY
TEST MANUAL
• INTERCHANGEABILITY
AND REPLACEABILITY
EVALUATION MANUAL
• WEIGHT CONTROL
MANUAL
• PROCESS CAPABILITY
STUDYING MANUAL
• LIFE CYCLE COST
EVALUATION MANUAL
(10) • RELIABILITY TEST
MANUAL
• MAINTAINABILITY TEST
MANUAL
• PRODUCIBILITY TEST
MANUAL
• INSPECTABILITY
EVALUATION MANUAL
• TESTABILITY
EVALUATION MANUAL
• EMPLOYEES SKILL
LEVEL EVALUATION
MANUAL
• INPROCESS CAPABILITY
SURVEILLANCE MANUAL
• EQUIPMENT OR MACHINE
COMMONALITY
SURVEILLANCE MANUAL
(11) • PROCUREMENT
REGULATION
(12) • PROCESS DESIGN
REGULATION
(13) • EMPLOYEE PROCESS
FAMILIARIZATION MANUAL
(14) • PRODUCTION CONTROLLING
REGULATION
(15) • PROTOTYPE PRODUCTION
REGULATION
(16) • NEW PRODUCT EVALUATION
AND DECISION REGULATION
(17) • COSTOMER INFORMATION
HANDLING AND
FEEDBACK REGULATION



Fig, 10. QUALITY ASSURANCE FLOW CHART (EXAMPLE)-NO.2

RELIABILITY

I. MIYAUCHI
COUNSELOR
JUSE

1. DEFINITION OF RELIABLITY

A DEGREE OR NATURE FOR STATING OF FUNCTIONAL STABILITY BY TIME-WISE FOR A SYSTEM, EQUIPMENT OR COMPONENT.

SOMETIMES, USED AS PHENOMENON AND MEASUREMENT INDEX.

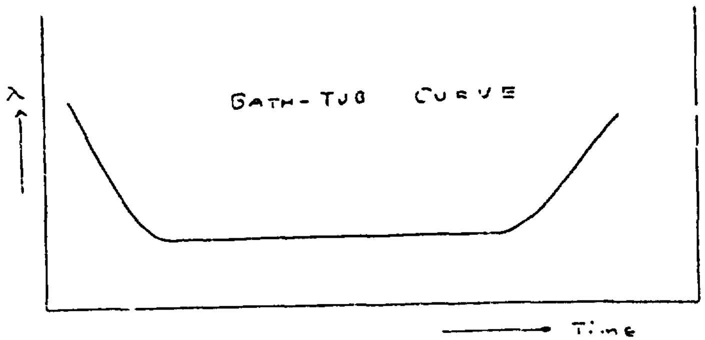
2. KINDS OF RELIABILITY

		RELIABILITY
PRODUCT	CONSUMABLE PRODUCT	RELIABILITY (NARROWER)
	REPARABLE PRODUCT	RELIABILITY + MAINTENABILITY = RELIABILITY (BROADER)

RELIABILITY
- INHERENT RELIABILITY
- OPERATIONAL RELIABILITY

3. RELIABILITY INDEX

A SYSTEM, EQUIPMENT OR COMPONENT,
UNDER A SPECIFIC CONDITION,
DURING INTENDED TIME SPAN,
CAN PERFORM A SPECIFIC FUNCTION
UNDER A PROBABILITY.



EXAMPLE:

RELIABILITY INDEX	: 99.9 %
MTBF (MEAN TIME BETWEEN FAILURE)	: 5,000 HR
MTBR (MEAN TIME BETWEEN REPAIR)	: 4,000 HR
MTBM (MEAN TIME BETWEEN MAINTENANCE)	: 3,000 HR
MTTF (MEAN TIME TO FAILURE)	: 8,000 HR
FAILURE RATE	: 5 %/HR

FUNCTION \ ORGANIZATION (TYPICAL)	ENGINEERING	PRODUCTION	MARKETING	FINANCE	PERSONNEL	------	OBJECTIVES
NEW PRODUCT DEVELOPM'T	O	O					BRAND-NEW PRODUCT
DESIGN CONTROL	O			O			BETTER THAN COMPETITORS
MATERIAL CONTROL		O		O			CHEAPER & BETTER MATERIAL
PRODUCTION CONTROL		O					TIMELY ENOUGH QUANTITY
QUALITY CONTROL		O					CONFORMANCE TO REQUIREMENT
COST CONTROL				O			REASONABLE PRICE
SALES CONTROL			O				MORE MARKET-SHARE
PERSONNEL CONTROL					O		WITH FULL QUALITY AWARENESS
EQUIPMENT CONTROL		O					WITHOUT ANY DOWN-TIME
RELIABILITY CONTROL	O	O	O				WITH LONGER LIFE

4. RELIABILITY MANAGEMENT

5 W 1 H APPROACHES ARE RECOMMENDED AS FOLLOWS:

WHY : TO ACHIEVE CUSTOMER SATISFACTION

WHAT : TO SPECIFY RELIABILITY PROGRAM

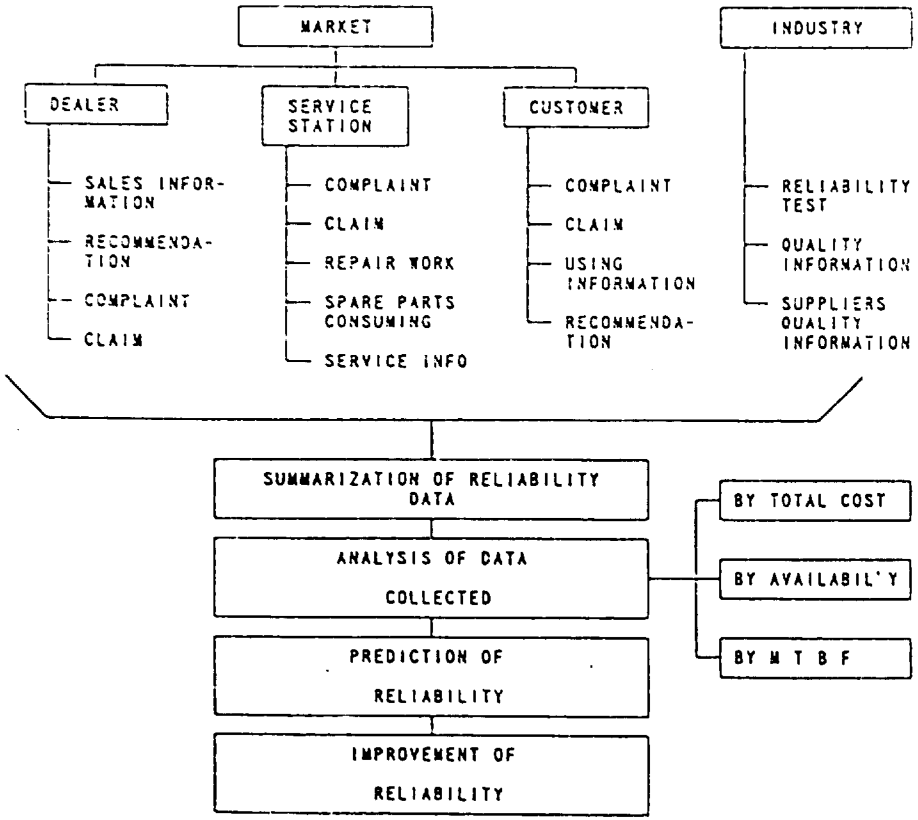
WHERE : TO MANAGE PRODUCT LIFE CYCLE

WHEN : TO SUSTAIN AT EVERY STAGE OF LIFE CYCLE

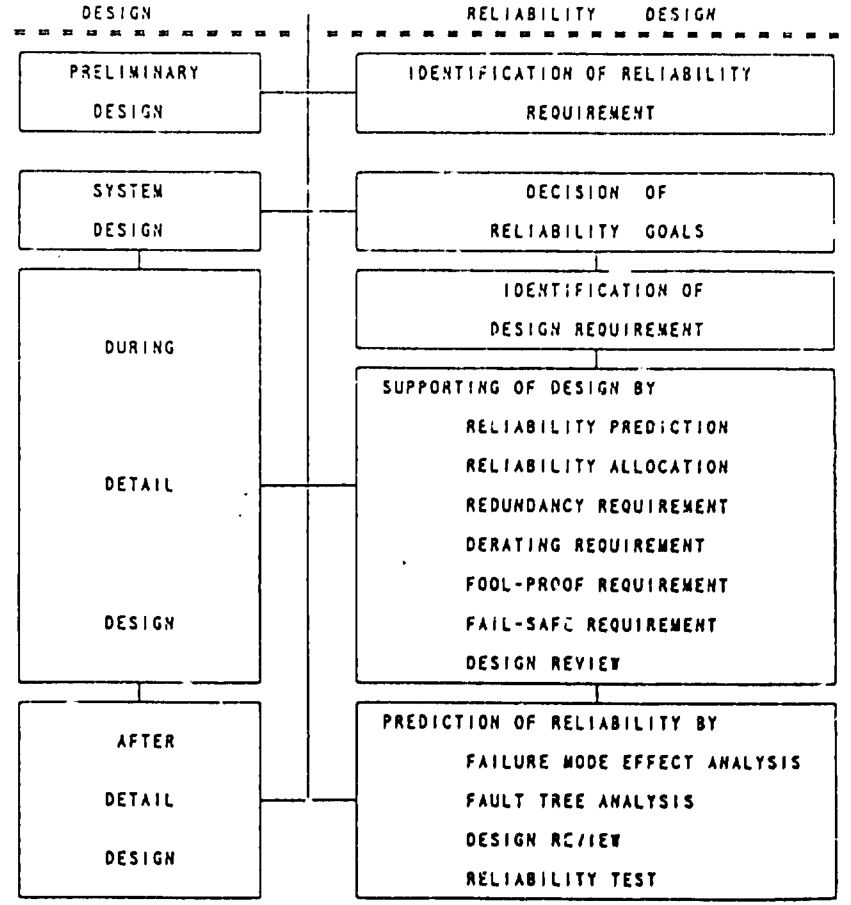
WHO : TO MANAGE BY RELIABILITY AND OTHER RELATED SECTIONS

HOW : TO MANAGE BY QC STORY

5. RELIABILITY DATA COLLECTION



6. RELIABILITY DESIGN SEQUENCE



7. RELIABILITY DESIGN SEQUENCES

(1) RELIABILITY GOAL DECISION -- PREDICTION

(2) RELIABILITY GOAL ALLOCATION

(3) REDUNDANCT SYSTEM REQUIREMENT DECISION

(4) FAIL-SAFE DESIGN REQUIREMENT

(5) FOOL-PROOF (POKA-YOKE) DESIGN

(6) DERATING DESIGN

(7) TRADE-OFF DESIGN

(8) FAILURE MODE EFFECT ANALYSIS

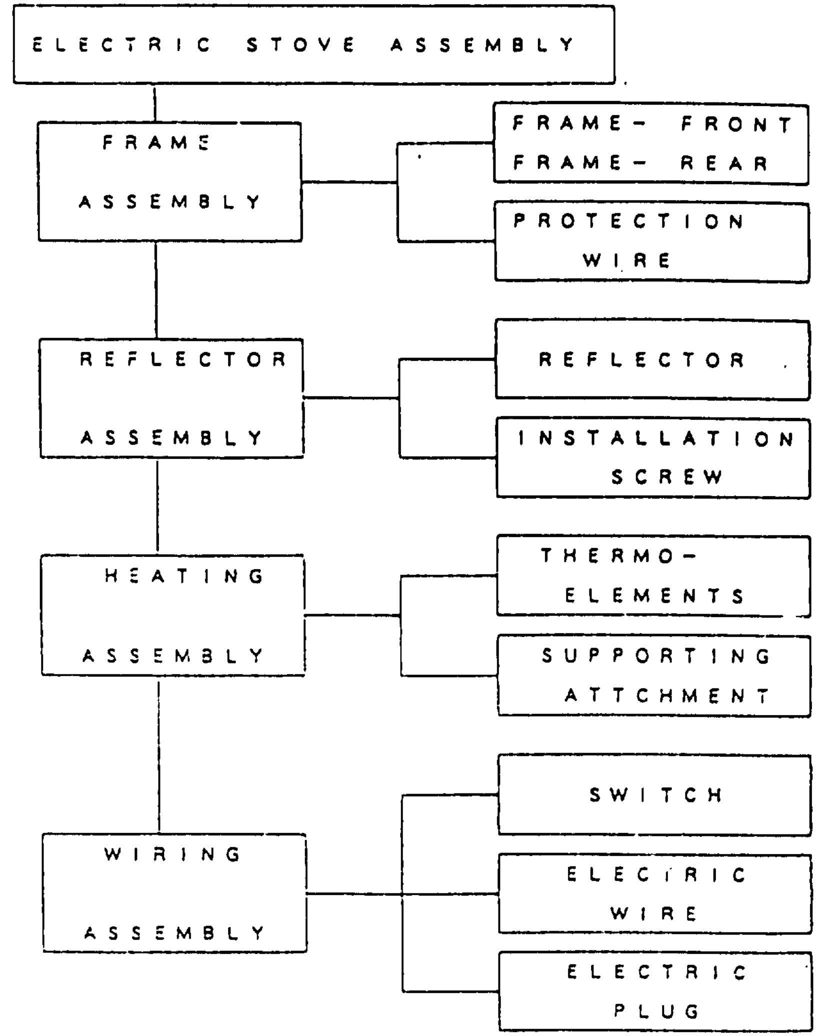
(9) FAULT-TREE ANALYSIS

(10) SAFE-LIFE DESIGN

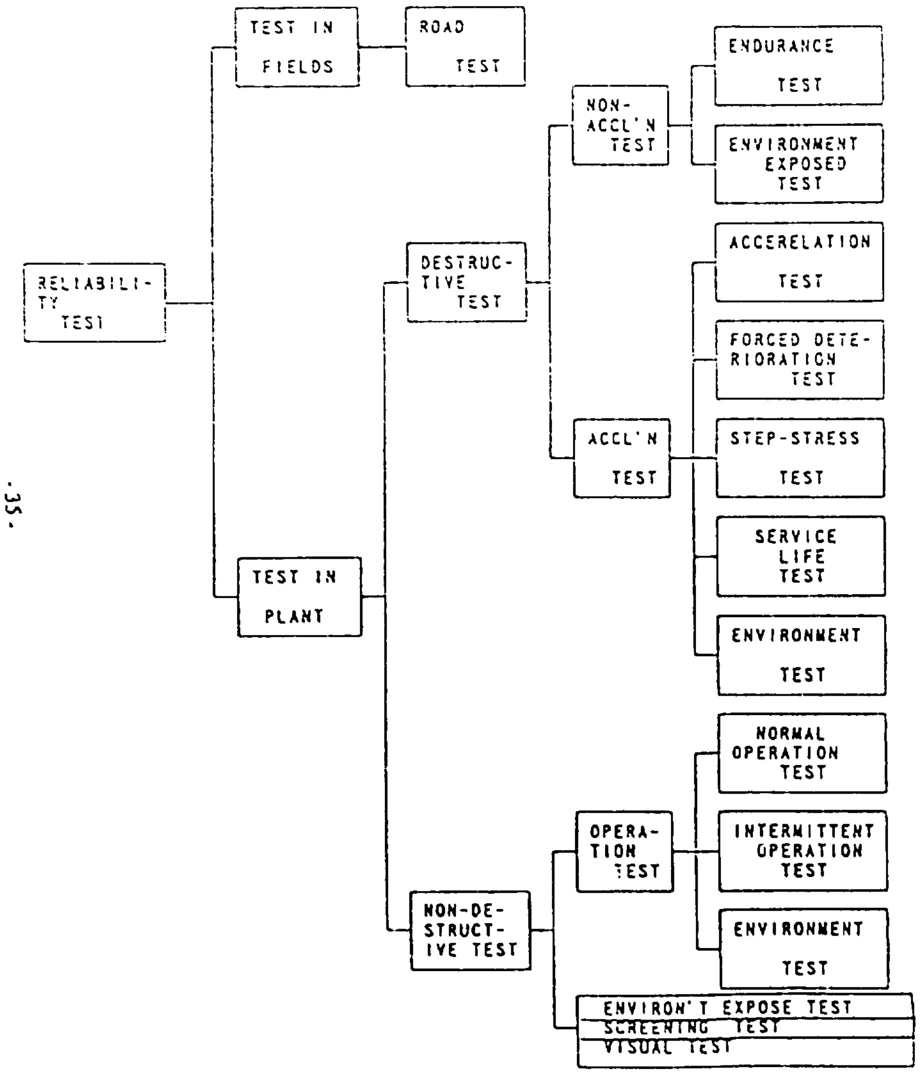
(11) RELIABILITY TEST

(12) DESIGN REVIEW AT PRELIMINARY
AT SYSTEM
AT DETAIL

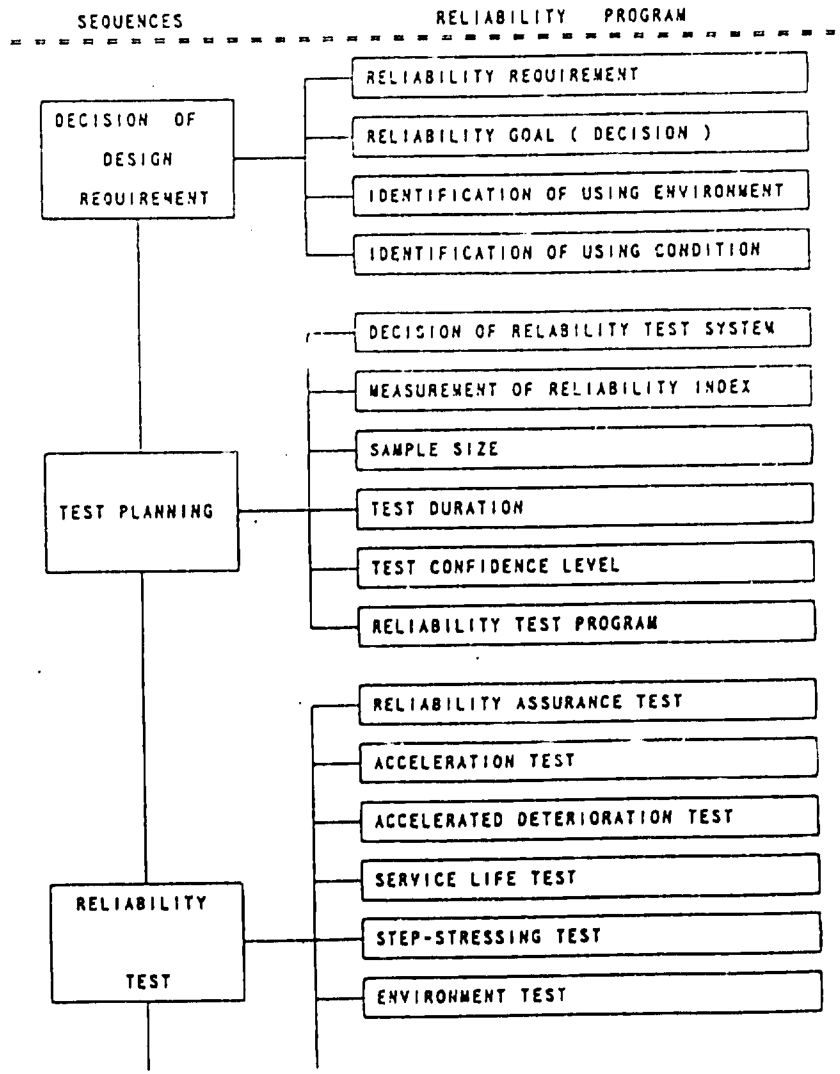
8. RELIABILITY BLOCK-DIAGRAM

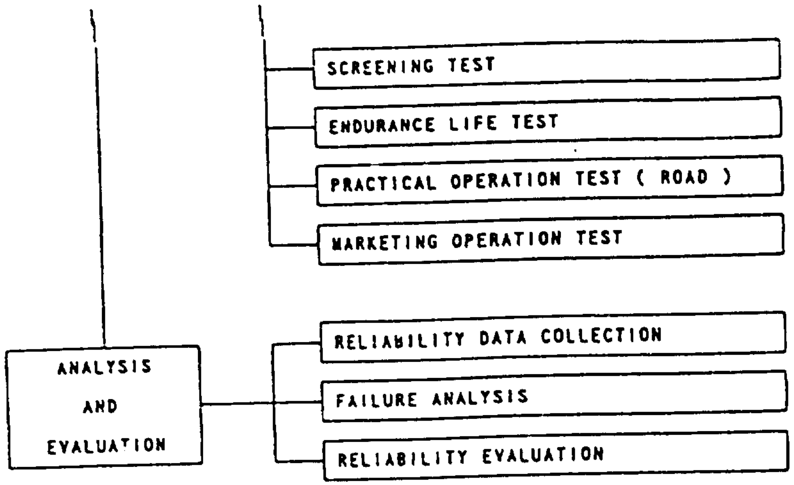


9. KINDS OF RELIABILITY TEST



10. RELIABILITY TEST PROGRAM





11. MAINTENANCE

DEFINITION:

AN ACTION TO SUSTAIN A RELIABILITY OF REPARABLE SYSTEM, EQUIPMENT OR COMPONENT.

FOR THAT, IT IS NECESARY TO IDENTIFY:

A) IF PRODUCT IS DESIGNED FOR EASY MAINTENANCE

B) IF SPECIFIC SKILLED MAINTENANCE PERSONNEL ARE REQUIRED

C) IF SPARE PARTS OR COMPONENTS ARE ALWAYS AVAILABLE

THE ABOVE THREE ARE CALLED AS "MAJOR ELEMENTS" FOR MAINTENANCE

12. MAINTAINABILITY

DEFINITION

A DEGREE OR NATURE TO STATE EASINESS OF MAINTENANCE ACTION FOR REPARABLE SYSTEM, EQUIPMENT, OR COMPONENT, AND MAINTAINABILITY INDEX:

A PROBABILITY TO STATE UNDER SPECIFIC CONDITION, WHEN PERFORMING MAINTENANCE ACTION IF ACCOMPLISHABLE WITHIN SPECIFIC TIME SPAN

13. MAINTENACE ENGINEERING

A) FUNDAMENTAL FUNCTION

-- ESTABLISHMENT OF MAINTENANCE SYSTEM

-- ESTABLISHMENT OF MAINTENANCE PHASE

-- ESTABLISHMENT OF MAINTENANCE CYCLE

-- ESTABLISHMENT OF MAINTENANCE DESIGN

B) MAINTENANCE PERSONNEL PLAN

-- MAINTENANCE MAN-POWER AND ASSIGNMENT

-- MAINTENACNE JOB ANALYSIS AND PREDICTION

-- MAINTENANCE TIME PREDICTION

-- MAINTENANCE MAN-HOUR PREDICTION

-- EDUCATION AND TRAINING PROGRAM

-- ESTABLISHMENT OF MAINTENANCE STANDARD OPERATION PROCEDURE

-- ESTABLISHMENT OF TROUBLE SHOOTING PROCEDURE

-- ESTABLISHMENT OF DEAGNOSIS PROCEDURE

-- ESTABLISHMENT OF CHECK-OUT PROCEDURE

D) EQUIPMENT AND MACHINERY

-- TEST AND INSPECTION SYSTEM PREPARATION

-- CALIBRATION SYSTEM AND PROGRAM PREPARATION

E) SPARE PARTS

-- SPARE PARTS PREDICTION

-- STOCK-LEVEL PREDICTION

-- AGE-CONTROL ITEM SELECTION, AND CONTROLLING PROCEDURES ESTABLISHMENT

14. MAINTAINABILITY INDEX

MTTR (MEAN TIME TO REPAIR):

AVERAGE TIME FOR CORRECTIVE MAINTENANCE ACTION

$$= \frac{\text{total maintenance time}}{\text{total maintenance action}}$$

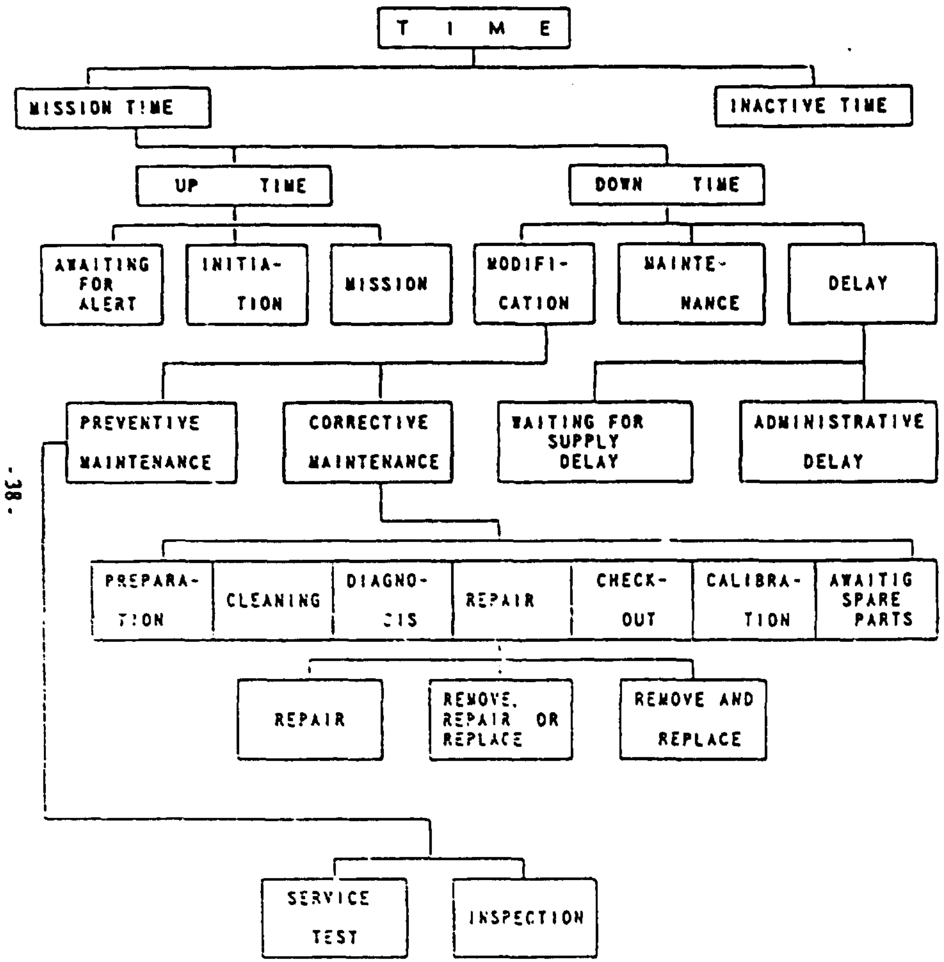
AVAILABILITY

$$= \frac{MTBF}{MTBF + MTTR}$$

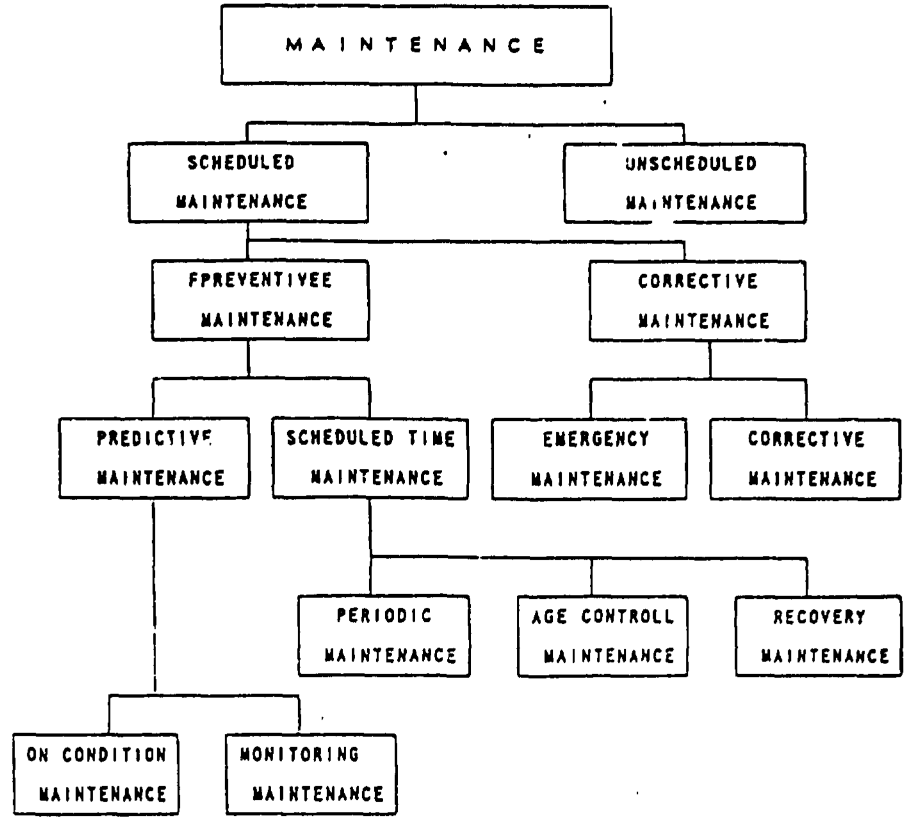
$$= \frac{(\text{UP TIME})}{(\text{UP TIME}) + (\text{DOWN TIME})}$$

2/14

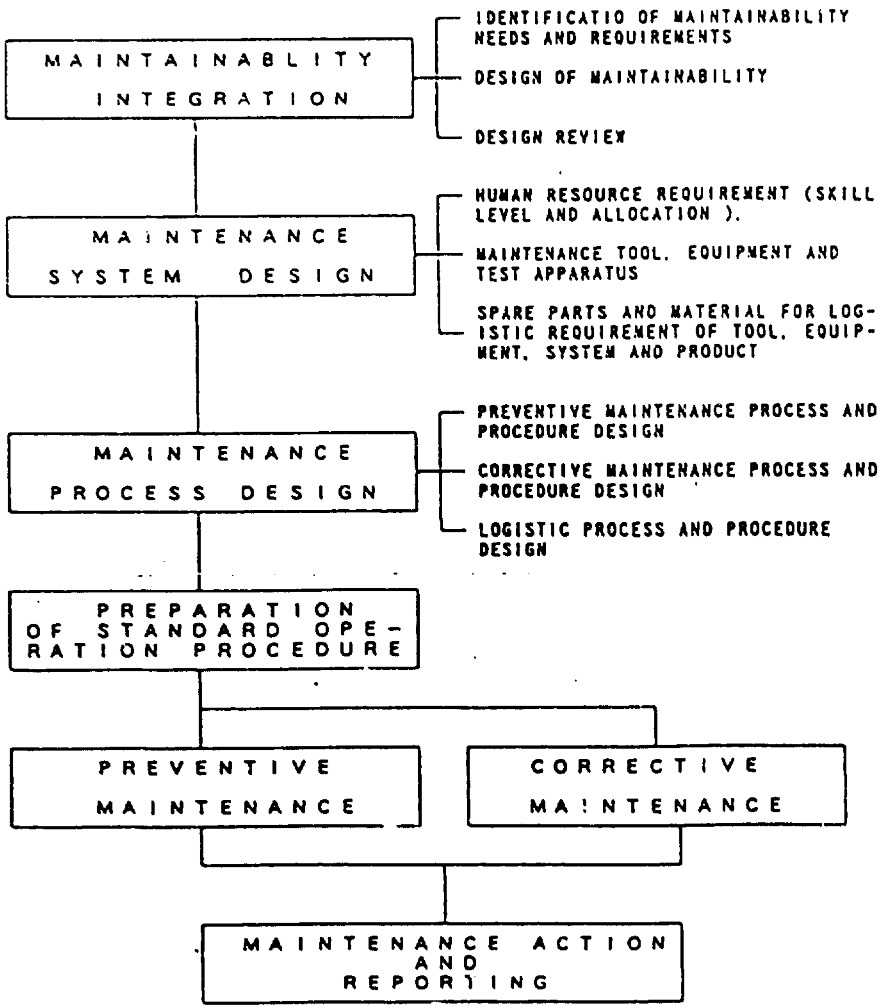
15. TIME STRUCTURE



16. MAINTENANCE ACTION



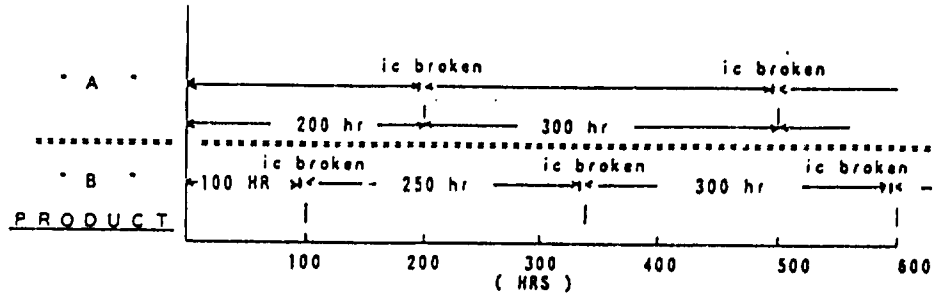
17. PREVENTIVE MAINTENANCE CONCEPT



CALCULATION

1. M T B F (MEAN TIME BETWEEN FAILURE)

FOR REPARABLE PRODUCT (WASHING MACHINE)



OPERATION TIME

FORMULA :

$$MTBF = \frac{X_1 + X_2 + \cdots X_{n-1} + X_n}{r \text{ (NO. OF FAILURES)}}$$

WHERE : X_n = operation time to failure

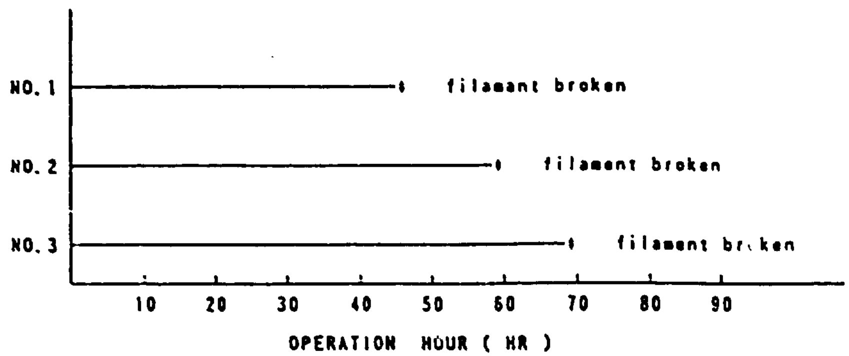
r = number of failure observed

$$MTBF_A = \frac{200 + 300}{2} = \frac{500}{2} = 250 \text{ (HR)}$$

$$MTBF_B = \frac{100 + 250 + 300}{3} = \frac{650}{3} = 216.7 \text{ (HR)}$$

2. MTTR (MEAN TIME TO FAILUE)

FOR CONSUMABLE PRODUCT (ELECTRIC BULB)



FORMULA :

$$MTTF = \frac{X_1 + X_2 + --- X_{n-1} + X_n}{r \text{ (NO. OF FAILURE)}}$$

WHERE : X = OPERATING TIME TILL BROKEN

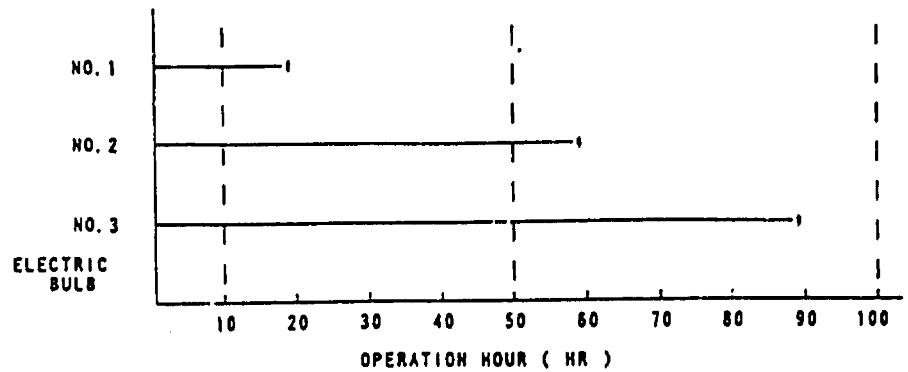
r = NUMBER OF FAILURE OBSERVED

$$MTTF_{BULB} = \frac{50 + 60 + 70}{3} = \frac{180}{3}$$

$$= 60 \text{ (hr)}$$

3. RELIABILITY INDEX

FOR ELECTRIC BULB



FORMULA :

$$R = \frac{N - r}{N}$$

WHERE : N = WHOLE NUMBER OF PRODUCTS RELATED

r = FAILURE NUMBER OBSERVED AT SPECIFIC OBSERVATION HOUR

$$R \text{ (at 10hr)} = \frac{3}{3} \times 100 = 100 \%$$

$$R \text{ (at 50hr)} = \frac{2}{3} \times 100 = 67 \%$$

$$R \text{ (at 100hr)} = \frac{0}{3} \times 100 = 0 \%$$

4. MTTR (MEAN TIME TO REPAIR)

FOR REPARABLE PRODUCT

N C MACHINES IN MACHINE-SHOP ARE RECEIVED MAINTENANCE ACTIONS AS FOLLOWS. THAT CALCULATE THE "M T T R".

MAINTENANCE ACTIONS	MAINTENANCE DURATION
20 TIMES	1 HR
10 TIMES	2 HR
5 TIMES	3 HR
3 TIMES	4 HR
1 TIME	5 HR
1 TIME	6 HR

FORMUALA:

$$MTTR = \frac{\text{TOTAL MAINTENANCED HOURS}}{\text{TOTAL MAINTENANCED NUMBERS}}$$

$$MTTR = \frac{(20 \times 1 + 10 \times 2 + 5 \times 3 + 3 \times 4 + 1 \times 5 + 1 \times 6)}{(20 + 10 + 5 + 3 + 1 + 1)}$$

$$= \frac{(20 + 20 + 15 + 12 + 5 + 6)}{40} = \frac{78}{40}$$

= 1.9 HRS

5. MAINTAINABILITY INDEX

FOR REPARABLE PRODUCT

WHEN SHIPPED 25 N/C MACHINES TO CUSTOMEP, THE FOLLOWING STATED REPAIRING DATA ARE OBTAINED. CALCULATE MAINTAINABILITY INDEX ?

REPAIRING HOUR TABLE

(UNIT:MIN)

79	40	67	45	65	98
51	77	59	60	90	65
48	67	44	68	74	57
78	38	86	64	51	45

PROCEDURES:

A) PREPARE HISTOGRAM FOR THE ABOVE DATA

B) CALCULATE THE MAINTAINABILITY INDEX AT A SPECIFIC HOUR

FORMULA

$$\text{MAINTAINABILITY INDEX} = \frac{\text{REPAIRING NUMBERS AT A SPECIFIC HOUR}}{\text{TOTAL REPAIRED NUMBER}}$$

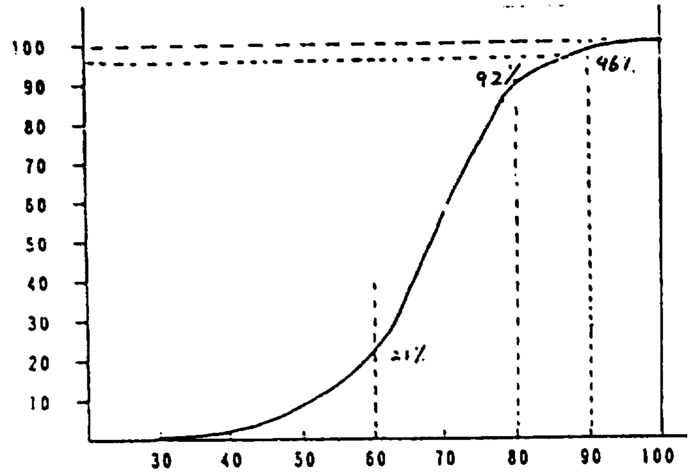
MAINTAINABILITY INDEX (AT 100 MINUTES) = $\frac{24}{24}$ = 100 %

M (AT 90 MINUTES) = $\frac{23}{24}$ = 96 %

M (AT 80 MINUTES) = $\frac{22}{24}$ = 92 %

M (AT 60 MINUTES) = $\frac{5}{24}$ = 21 %

M (AT 40 MINUTES) = $\frac{2}{24}$ = 1 %



-42-

MURPHY'S LAW

IF ANYTHING CAN GO WRONG, IT WILL.

MURPHOLOGY

IF A SERIES OF EVENTS CAN GO WRONG IT WILL DO SO IN THE WORST POSSI-BLE SEQUENCE.

NATURE ALWAYS SIDES WITH THE HID-DEN FLAW.

YOU ALWAYS FIND SOMETHING THE LAST PLACE YOU LOOK.

EVERYTHING PUT TOGETHER FALLS APART SOONER OR LATER.

IF YOU EXPLAIN SO CLEARLY THAT NO-BODY CAN MISUNDERSTAND, SOMEBODY WILL.

IF YOU DO SOMETHING WHICH YOU ARE SURE WILL MEET WITH EVERYBODY'S APPROVAL, SOMEBODY WON'T LIKE IT.

TQC IN SERVICE

CONVENTIONAL QUALITY CONTROL

- FURNISHMENT OF SERVICE
- IMPROVEMENT OF SERVICE
- IMPROVEMENT OF SERVICE SYSTEM

TQC FOR SERVICE QUALITY

- ESTABLISHMENT OF QULITY SERVICE SYSTEM
- DECISION FOR SERVICE QUALITY
- DECISION FOR LEVEL OF SERVICE QUALITY
- DECISION FOR GUARANTEEING QUALITY
- ESTABLISHMENT FOR PROCEDURES OF SERVICE QUALITY
- IMPLEMENTATION OF PROCEDURES

COMPARISON BETWEEN PRODUCT AND SERVICE QUALITY

PRODUCT	SERVICE
SELL VISIBLE HARD-WARE OR COMMODITY	SELL VISIBLE AND INVISIBLE SOFT-WARE AND BEHAVIOR
SELL FUNCTIONS AND PERFORMANCE OF PRODUCT	SELL VISIBLE AND INVISIBLE FUNCTION AND PERFORMANCE OF SERVICE
SELL ADDED-VALUE OF PRODUCT	SELL INVISIBLE AND VISIBLE ADDED-VALUE OF SERVICE
SELL QUALITY OF PRODUCT	SELL QUALITY OF SERVICE
CAR: SAFETY RELIABILITY PERFORMANCE FUEL CONSUMPTION ADEQUATE PRICE QUICK DELIVERY BRAKE RESPONSIVENESS LIGHT WEIGHT EASY MAINTENANCE	TEA-ROOM: TASTEFUL TEA/COFFEE AROMATIC TEA/COFFEE GRACE TEA-CUP COMFORTABLE CHAIR & TABLE WARM TREATMENT QUICK TEA SERVICE ADEQUATE PRICE COMFORTABLE ATMOSPHERE CLEAN FLOOR QUIET, NOISELESS, AND CALM ENVIRONMENT GOOD MUSIC EXCELLENT PLAYER & MICROPHONE

-5ろ

EVALUATION OF DAILY ROUTINE-WORK MANAGEMENT

level	CRITERIA	CHECK POINT
1	NOT CLEAR OFFICE DUTY	-available, but too old -not clearly stated for duty responsible
2	DUTY PRIORITY ARE NOT SPECIFIED	-not specified for critical, major, nor minor duty
3	DUTY GOALS ARE NOT ESTABLISHED	-can't evalute if accomplished or not
4	NO S.O.P	-can't have consistent quality-work
5	ANY DATA NOT AVAILABLE	-can't evaluate if conform with s o p requirement
6	HAVE DATA, BUT NO GOALS	-ditto
7	DATA ARE NOT VISUALIZED	-rather hard to visually evaluate at a glance
8	CORRECTIVE ACTION IS NOT FOR ROOT-CAUSE	-although dispersion are visible, but only probable causes are consider for corrective action, not for rootcause
9	NO RECURRENT PREVENTIVE ACTION TAKEN	-after corrective action be taken, no standardization are established
10	FULL IMPLEMENTATION OF RECURRENT PREVENTIVE ACTION, AND APPLIDE TO ANOTHER SIMILAR AREA AT THE SAME TIME	-TQC is fully implemented by P-D-C-A cyclic actions

ESTABLISHM'T OF CORRECTIVE ACTION

- IDENTIFICATION FOR
  - PROBABLE
  - POTENTIAL
  - ROOT

  causes
- ESTABLISHMENT FOR CORRECTIVE ACTION AGAINST ROOT-CAUSE
- REVISE S O P

PROCEEDING ON IMPROVEMENT

- IDENTIFICATION FOR IMPROVEMENT NEEDS
- PRIORITIZE FOR IMPROVEMENT NEEDS UNDER VITAL-FEW CONCEPT
- ESTABLISHMENT OF IMPROVING PLAN (ESTABLISHMENT OF GOAL & SCHEDULE)
- FOLLOW QC STORY (PLAN-DO-CHECK-ACT cyclic action)
- EVALUATE RESULT OBTAINED FOR EFFECTIVENESS
- IF CONFIRMED, PUT IT INTO S O P

  IF NOT, REPEAT P-D-C-A cycle

EVALUATION AND RECOGNITION BY SENIOR & TOP MGTs

- INCORPORATION OF CONTINUOUS IMPROVEMENT CONCEPT ON DAILY ROUTINE-WORK MANAGEMENT BY EVERY MIDDLE-MANAGEMENT
- RECOGNITION BY SENIOR AND TOP MANAGEMENT FOR SUCH AUTONOMOUS IMPROVEMENT

6カ·

DEFINITION OF QUALITY

- MEDICAL NEEDS
- SERVICE QUALITY
- TIME ALLOCATION
- SAFETY
- BEHAVIOR
- SERVICE COST
- MAINTENANCE NEED
- NATIONAL REGULATION REQUIREMENT
- INTERNATIONAL COMMON (WHO) REQUIREMENT

ESTABLISHM'T OF CONTROL ITEM

- ESTABLISHMENT FOR
  - <u>what index</u>
  - <u>when</u>
  - <u>where</u>
  - <u>who</u>
  - <u>how</u>
  - <u>why</u>

  → TO MEASURE
- ESTABLISHMENT FOR FORMAT TO RECORD
- EDUCATE & TRAIN FOR IMPLEMENTATION

IMPFLEMENT'N OF S O Ps

- FOLLOW S.O.P AS SPECIFIED BY
- RECORD FOR ACTION TAKEN
- EVALUATE RESULT OBTAINED FOR:
  - if oked, sustain as is.
  - if not, take corrective actior

TQC APPROACH FOR SERVICE ⟨SECTORS / INDUSTRY⟩

- **FUNCTION DEFINITION**
  - HORIZON
  - VISION
  - STRATEGY
  - POLICY & GOAL
- **FUNCTION DEPLOYMENT**
  - BUSINESS PLAN
  - MEDICAL PLAN
  - FINANCIAL PLAN
  - HUMAN RESOURCE REQUIREMENT PLAN
  - SYSTEM PLAN
  - ORGANIZATION PLAN
  - OPERATION PLAN
  - EVALUATION PLAN
- **DEFINITION OF OPERATION**
  - ESTABLISHMENT OF SYSTEM FLOW AND EACH SUB-SYSTEM RESPONSIBILITY
  - ESTABLISHMENT OF ORGANIZATIONAL FLOW CHART AND HIS REPONSIBILITY
  - ESTABLISHMENT OF OPERATIONAL FLOW-CHART BY ORGANI-ZATIONS TO DEFINE RESPONSIBILITY
  - ESTABLISHMENT OF STANDARD OPERA-TION PROCEDURES TO SPECIFY SPECI-FIC OPERATIONAL PROCEDURE FOR RESPONSIBILITY ACCOMPLISHMENTS

-/h

SPECIFIC FEATURE OF SERVICE

1. SERVICE CANNOT BE STOCKPILED.

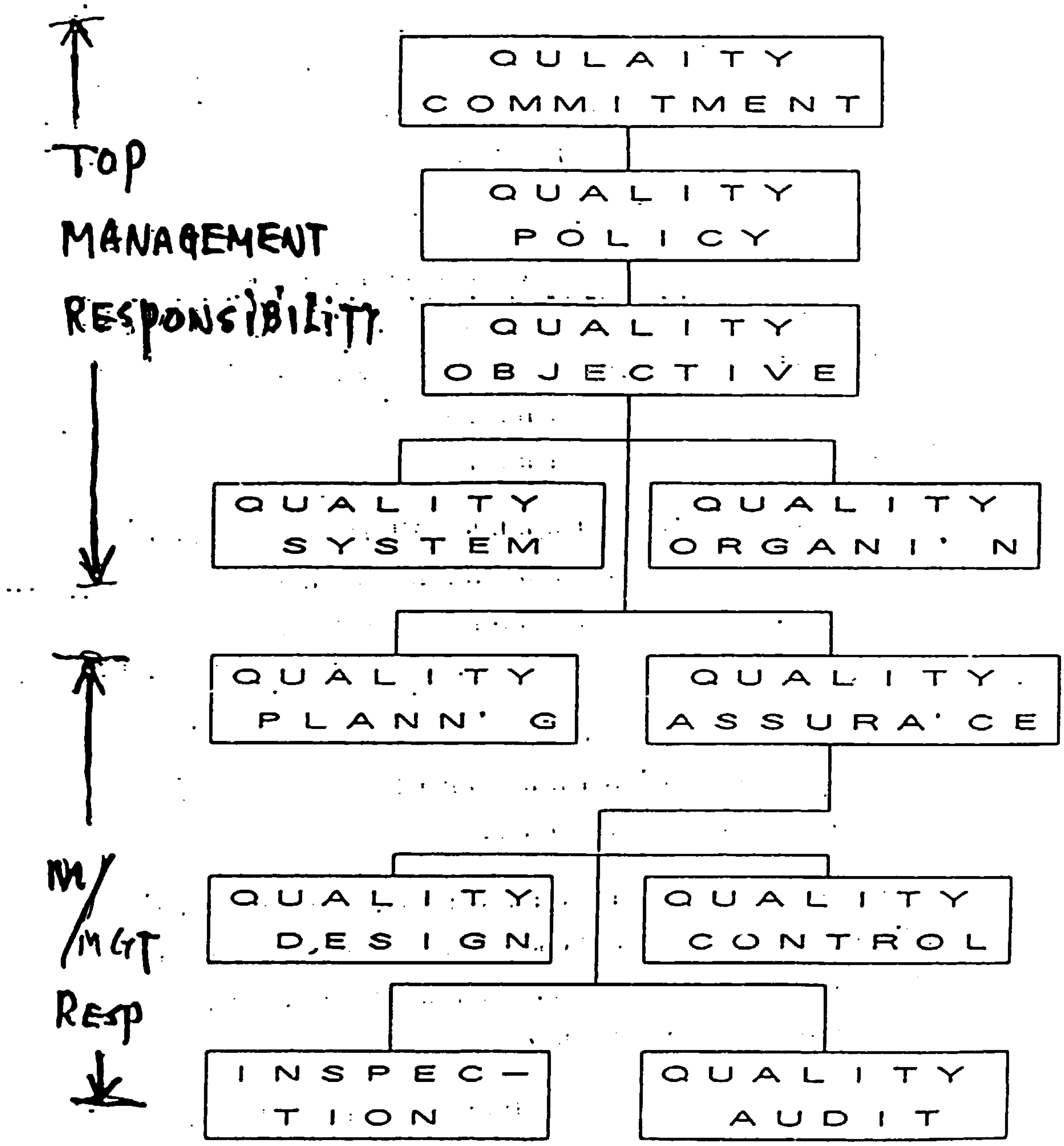
2. CUSTOMER DEMANDS FOR SERVICE ARE SO VARIED THAT THEIR EXPECTS MUST BE IDENTIFIED FIRST.

3. SERVICE WORK ITSELF ARE SO MUCH RELATED WITH PERSONAL BEHAVIOR. THAT IS, INDIVIDUAL DECISION IS PLAYING A MAJOR ROLE.

4. SERVICE WORK ARE PERSONAL-, PHYSICAL-, AND MENTAL-ORIENTED DIRECT RESPONSIVE ACTIONS.

5. CUSTOMERS' SATISFACTION, UNSATISFACTION, OR DISCOMFORT ARE DIRECT AND PHYSICAL COMPREHENSION BY PERSONNEL RELATED.

6. BAD REPUTATION RUNS FAST, HOWEVER GOOD ONES ARE REVERSE. THAT IS, THE BAD ARE ACTIVELY EVALUATED, BUT THE GOOD ARE NEGATIVELY.



TOP
MANAGEMENT
RESPONSIBILITY
QULAITY COMMITMENT
QUALITY POLICY
QUALITY OBJECTIVE
QUALITY SYSTEM
QUALITY ORGANI' N
QUALITY PLANN' G
QUALITY ASSURA' CE
M/MGT
Resp
QUALITY DESIGN
QUALITY CONTROL
INSPEC-TION
QUALITY AUDIT

2–WEEK TRAINING COURSE
FOR FCAV, BRAZIL
UNIDO PROJECT
(TF/BRA/92/B10, DP/BRA/92/004)

STANDARDIZATION

Ichiro MIYAUCHI

COUNSELOR, J U S E

UNION OF JAPANESE SCIENTISTS AND ENGINEERS

UNION OF JAPANESE SCIENTISTS AND ENGINEERS
(NIPPON KAGAKU GIJUTSU RENMEI)
5–10–11, Sendagaya, Shibuya–ku, Tokyo 151, JAPAN

STANDARDIZATION

1. GENERAL

A) It is absolutely necessary to implement quality control by every employee in every department to assure customer requirements or needs. However, to measure if customer requirements or needs are fully integrated into products or services, some sorts of definite measurable standards are required to be established for assuring for customer satisfaction.

Hereby, the standards are basic essentials in quality control and are respected and precious principles in industrial fields.

Standardization is how to establish such kinds of standards by systematic ways and how to utilize the standards effectively, which are organized by flow chart, written procedures and format for recording of processed and results.

B) **5.2 Structure of the quality system**

5.2.1 General

Management is ultimately responsible for establishing the quality policy and for decisions concerning the initiation, development, implementation and maintenance of the quality system.

5.2.2 Quality responsibility and authority

Activities contributing to quality, whether directly or indirectly, should be identified and documented, and the following actions taken :

a) General and specific quality responsibilities should be explicitly defined.

5.2.5 Operational procedures

The quality system should be organized in such a way that adequate and continuous control is exercised over all activities affecting quality. Operational procedures coordinating different activities with respect to an effective quality system should be developed, issued and maintained to implement corporate quality policies and objectives. These procedures should lay down the objectives and performance of the various activities having an impact on quality, e.g. design, development, procurement, production and sales.

C) Kinds of Standards

(1) International Standards
- I.S.O.
- I.E.C.

(2) National Standards
- Compulsory
- Voluntary

(3) Regulatory Standards

(4) Enterprises Standards

2. OBJECTIVES OF STANDARDIZATION

The standardization is a mandatory requirements in quality assurance concepts.

A) To have quality sustaining and improvement for
- Performance and function assurance and their improvement
- Reliability and maintainability assurance and their improvement
- Safety assurance and its improvement
- Interchangeability improvement dimensionally, functionally in every component
- Replaceability improvement
- Minimum component utilization
- Uniformed quality fabrication
- Elimination of in-processing difficulty or troubles
- Recurrent trouble prevention
- Standard operation procedures establishment

B) To have cost-reduction for
- Interchangeability improvement dimensionally, functionally in every components
- Minimum component utilization
- Simplification

C) To have productivity sustainment and improvement for
- Mass-production processing design and its improvement
- Inprocess improvement
- Automation or robotic operation improvement
- Computerization operation

D) To have information/dissemination for
- Technology and skill transferring
- Customer notification (public relation, advertisement, catalogue, etc.)
- In-house notification (company's regulation, rules specification, drawings, etc.)
- Certification or qualification's justification
- Education and training
- Morale improvement

E) To have social contribution for
- Customers safety assurance
- Pollution prevention and control
- Employees safety security

3. IN-HOUSE STANDARDIZATION

In-house standards are consisted of Regulation and Specification. Regulation specifies for company's management and operation functions, and specification is for technological and technical requirement for every operational processing in each department: as

Regulation
- Fundamental regulation
- Organizational and functional regulation
- Managemental regulation

Specification
- Technological and technical requirement
- Processing requirement
- Operational requirement

These relationship and processing flow chart is explained in Fig. 1.

A) Regulation

Regulation is generally consisted of

(1) Fundamental regulations which state for

- President/founder's creeds and philosophy for company's management
- The article of association
- Rule of CEO
- Rule of board meeting
- Stock handling rules

(2) Organizational regulations which state for

- Work regulation
  - Promotion
  - Pay system
  - Ethical code
- Rule of organization
- Rule of assignment
- Rule of committees

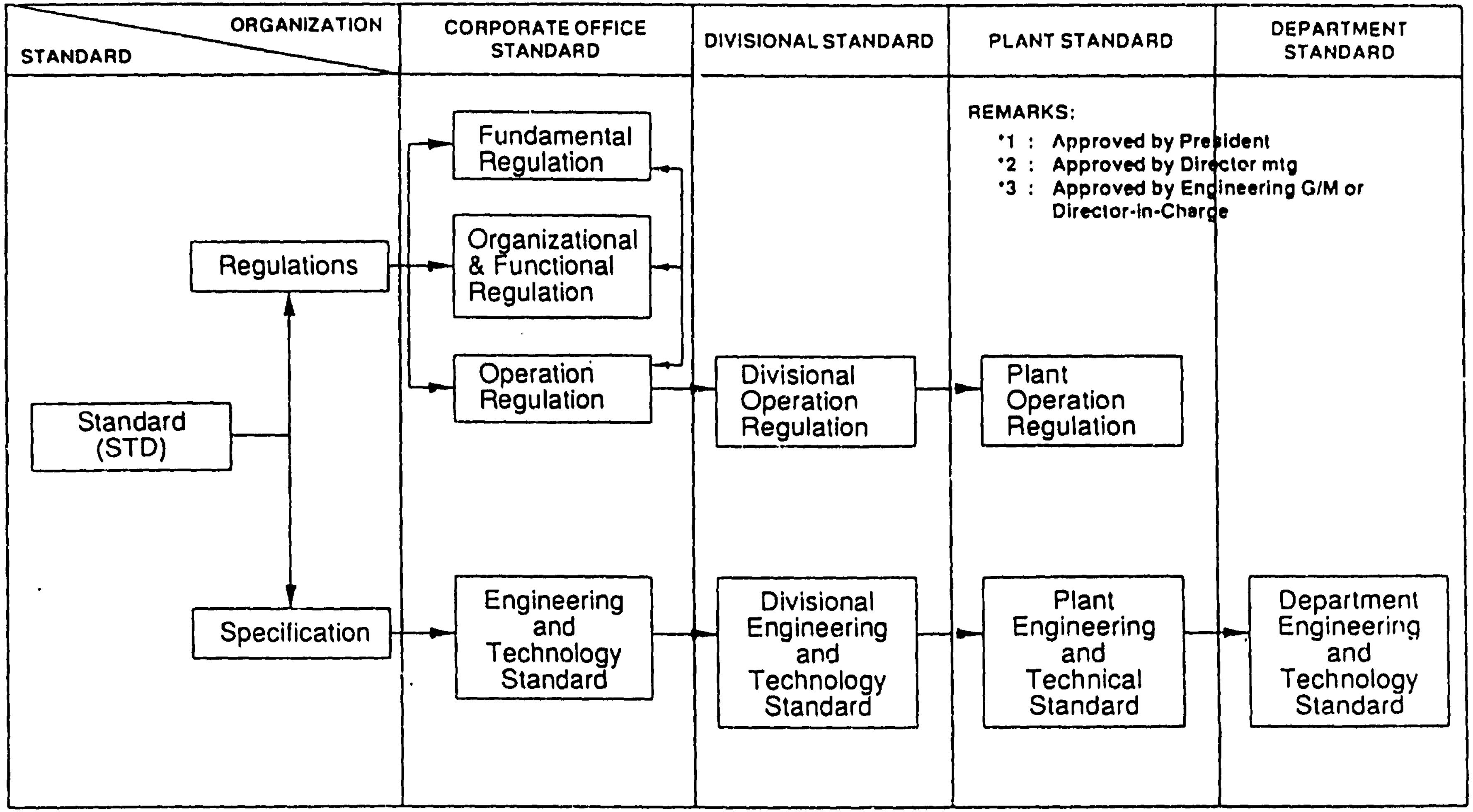


Fig. 1 Standards Establishing Flow

(3) Functional regulations

- Rule of job description statement
- Rule of General behavior
- Rule of Regulation establishment
  - Establishment
  - Approval
  - Distribution
  - Revision
  - Auditing
  - Controlling
- Rule of documentation
- Rule of education and training office function
- Rule of administration office function
- Rule of TQC office function (including QC Circle)
- Rule of personnel office function
- Rule of finance office function
- Rule of planning office function
- Rule of auditing office function
- Rule of procurement office function
- Rule of production and fabrication function
- Rule of engineering office function
- Rule of marketing office function
- Rule of quality assurance function
- Rule of pollution control office function
- Rule of industrial safety office function, etc.

(4) Management regulation

- Labor relation's regulation
- General stock-holders meeting regulation
- Senior directors meeting regulation
- directors meeting regulations
- Balance sheet preparation regulations
- Small report preparation regulations
- TQC concept implementation regulations, etc.

B) Specifications

Specifications are generally consisted of products/service standards, and operational/processing standards.

(1) Product/service specification

- Product/service specification
- Product/quality drawing
- Raw material specification
- Casting or forging drawing
- Pressing or stamping die drawing
- Test and inspection specification
- Inspection equipment, instrument, tool and gauge standards
- Engineering standards

- Drafting manual
- New product development standards
- Standardized parts/component specification, packaging or crating procedures and material standards
- Installation standards

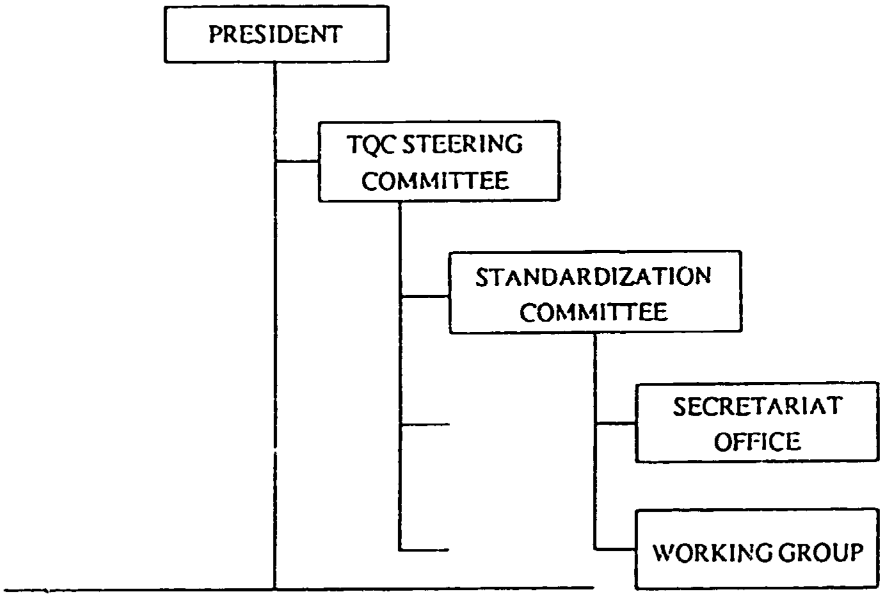
(2) Operational/processing standards

- Process analysis standards
- Special processes specification
  - For equipment
  - For personnel
  - For procedures
- Standard operation procedures
- Processing tags or slips
- Stock and inventory control instruction
- Market survey or research processing instruction
- Sales control instruction
- Transportation control instructions
- Quality information collecting, analyzing, recording, retrieval and controlling standards
- Logistic control standards

4. PREPARATION PROCEDURES FOR STANDARDIZATION

A) Installation of company-wide standardization steering committee

(1) First of all, standardization steering committee will be established under TQC steering committee. This committee is to be considered as a subcommittee of TQC as shown in the following



(2) Committee chairman: Recommend to be seated by V.P. or Sr. Director in charge of general affairs (Administration)

(3) Committee members: Management in every cross-functional organizations

(4) Secretariat office: Staff or management in administration office

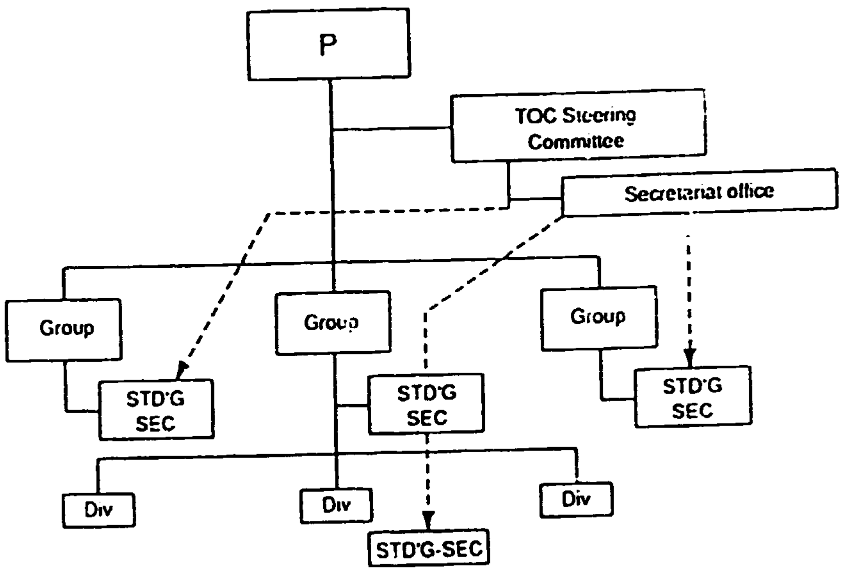
(5) Rule of steering committee

- Establish standardization promotion plannings and programs for
  - Standardization regulation establishing, planning, and dissemination, or updating programs
  - Re-evaluation of standards established for their necessity
  - Claim or complaint reduction program establishment and facilitation
  - Critical quality problem solution program establishment and facilitation
  - Establishment of production quality standard in production organizations
  - Preparation of standard operation procedures
  - Establishment of design quality standards
  - Establishment of quality evaluation standards and auditing standards
  - Establishment of company-wide quality assurance system evaluation standards

- Evaluation of standardizing processing and procedures established
- Determination of priority for establishment, revision or rescinding of every standard

B) Installation of sub-secretariat offices in higher echelon's offices

(1) After steering committee and secretariat are organized, every group, division or plant-wide secretariat offices for standardization expediting are needed to be installed as sub-secretariat/sub-sub-secretariat offices, depending on their priority, and to functionally cooperate with HQ's secretariat office:



(2) Role of sub-secretariat offices

These offices' roles are similar to the HQ's office. but they differ slightly in that they are rather software/hardware-oriented, or concentrating on routine work type standards establishment from company-wide oriented action, as shown in the following Fig. 2.

C) Standardization processing — when not fully standardized

When a company is not fully standardized yet for every operational procedures, it is better to follow as

(1) Firstly, understand top management commitment for standardization — why necessary to prepare by manager himself and disseminate to his subordinates

(2) Secondly, establish standards preparation program while consulting with his sub-or sub-sub secretariat offices within 5 years schedules.

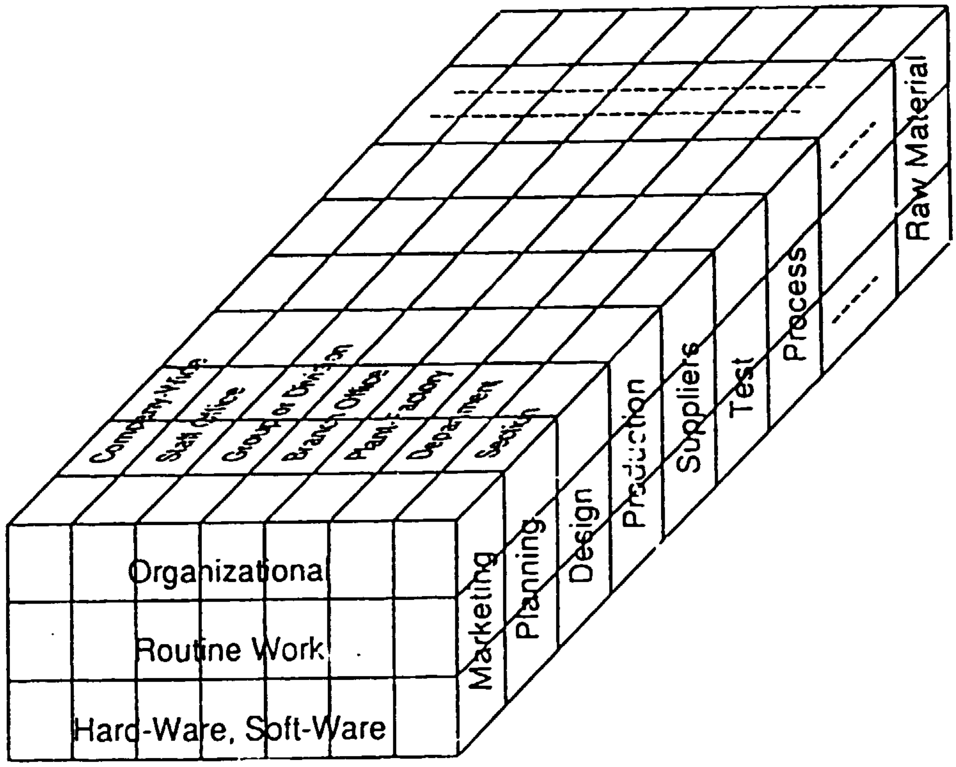


Fig. 2 Standardization Matrix For Subject Selection

(3) Thirdly, to prioritize standardization, organize brainstorm meeting with one's subordinates to identify status of standardization in his office/department for shake-down.

(4) Fourthly, evaluate the status obtained, and identify the weakness for standardization.

(5) Determine sectors necessary to establish standard with the highest priority based on customer satisfaction concept.

(6) Assign appropriate subordinates for establishing of the standards mentioned.

(7) Discuss draft standards with every subordinates for evaluation.

(8) If concurred, discuss with other related departments for coordination and pre-agreement (Nemawashi)

(9) Then submit to his superior for approval

(10) Send to the central ledgering office for numbering, distribution and matter-filing.

(11) Periodically, evaluate their effectiveness, and revise if possible, every 2 years

D) Standardization processing - already standardized

In case most of standardization has been finished.

(1) Improvement concentration

It is necessary to steadily concentrate more for improvement of standards established, based on specialization, simplification, and integration - concepts, such as

(a) Specialization

- to create more effective and economical processes or methods for specific, limited quantity production during fabrication or assembly work.

(b) Simplification

- to develop products with the least number of components or parts for assembly.
- to design product contours or shapes with more simple lines.
- to develop production processes with less processing on, or simple processing.

(c) Integration

- to use more common components or parts available in commercial shops.
- to process on more common commercial based work-shops.

(2) Timeliness concentration

When revision or improvement ideas are justified, these must be implemented as possible as one can for competitive dominancies, especially for changing of

- management policy
- organizational structure
- new product development
- suggestion proposal
- users/customers demands
- periodic survey summarization reports
- drastic upheaval forecastings
- competitors status and trends analysis

5. EVALUATION OF STANDARDIZATION

To evaluate the standardization in-house, the following 3 areas are necessary to consider.

(1) standardization promotion system and processings – time

(2) level of standards established – quality

(3) effectiveness of standards established – utilization

A) Evaluation of standardization promotion activity

(1) evaluate if standardization program is progressing as scheduled

(2) evaluate status of standardized numbers

(3) evaluate status of completion, revision or rescinding numbers

(4) evaluate how many product-models are consolidated or reduced.

(5) evaluate status of understanding and utilizing of standards established

(6) Evaluate the availability of necessary standards at every related work offices or shops

(7) Evaluate timeliness and effectiveness of establishment and revision for every standards

B) Evaluation of level of standards

(1) How many kinds of standards are established

for finished product
for component
for raw material
for auxiliary material

(2) How much communality are observed between every products

(3) How to evaluate every standard against competitors', when, who, what, how?

for policy & goal
for promotion system and structure
for promotion status
for progress status
for standards and specifications

C) Evaluation of effectiveness of standards established

In general, effectiveness formula is given as

$$\text{Effectiveness} = (\text{Quantitative value} + \text{Qualitative value}) - (\text{Standardization investment})$$

Where,

(1) Quantitatlve value = saving amount by standardization.

(2) Qualitative value = saving amount through productivity improvement, failure reduction, claim reduction, complaint reduction, service quality improvement, etc.

(3) Investment = Cost for new standards establishment, cost for condemned or retired equipment, cost for revision, etc.

However, these monitorial amounts are necessary to have cost accounting support for definite and accurate calculation that it may take sometime before calculations are finalized.

6. TIPS FOR STANDARDIZATION

During establishing of standards, it is necessary to pay attention to the following, (these are drawn out of our experiences),

A) Must be stated as action instruction, not as desire or expectation.

B) Must be clear-cut statement, and must not be misinterpreted by any personnel reading it.

C) Must not be any discretion

D) Must fit with each specific shop environment, and must be convenient for use.

E) Must be stated for inprocessing operation procedures, not for result controlling procedures.

F) Must be specified criteria for evaluation by operator himself, and must mention, when found out of criteria , what action be taken.

G) Must be easily understandable with illustrations or pictures

H) Must be revisable whenever necessary.

I) Must be traceable for revision or rescinding.

J) Must be easy to follow by any personnel.

7. QC PROCESS CHART/TABLE.

To implement "Inprocess control" concept during each processing operation, some sort of new procedures are necessary to insert into the conventional standard operation procedures (SOP).

In these new procedures such kinds of quality related informations as, every quality requirement. how to measure, how to evaluate its criteria are specified in every operation procedure as additional instruction as shown in the attached. Fig. 3 & 4, which are called as " Q.C. process chart/table".

Fig. 3 QC Processing Table (Example 1)

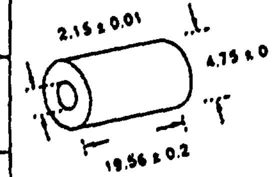
Part name: Tube				Part No. 00012222			Next Assembly No. 8015555				Change:		
Process No.	Flow		Operation Name	Machine Name and No.	Control condition		Sop No.	Measuring tool	Control procedures				Remarks
	Material	Process			Point	Criteria			Graph	Sampling	Procedures	In case of failure	
	▽	○	Rough machining	Lathe L-5001	Outside Ø Inside Ø Length	5 ± 0.2 2 ± 0.5 20 ± 1	101-1	Caliper (0 - 10)	Check sheet	n = 5 (every lot)	cp	Asst. foreman	
		○	Semi-finish machining	Lathe L-8005	Outside Ø Inside Ø Length	4.8 ± 0.2 2.1 ± 0.2 20 ± 0.5	101-2	Caliper (0 - 10)		n = 5 (every lot)	cp	Asst. foreman	
		○	Finish machining	Grinding Machine g 0004	Outside Ø Inside Ø Length	4.75 ± 0.1 2.15 ± 0.01 10.58 ± 0.2	101-3	Micrometer (0 - 5)	Control chart (X-R)	n = 5 (every 2 hs)	cp	Foreman	
		□	Inspection				101-4	Micrometer					
		○	Plating	Cr-plate	Cr-Thickness ???	0.05	101-5	Thickness meter	Control chart (X-R)			Foreman	
		□	Inspection				101-6	Visual		100% visual insp.	cp		
		○	Horning	Horning Machine 11-1002	Cr-Thickness (after ground)	0.04	101-7	Dial gauge	Control chart (X-R)	n = 5 (every 2 hs)	cp		
		□	Inspection				101-8	Dial gauge					
		▽	In process warehouse										

Fig. 4 QC Process Chart (Example 2)

Part Nomenclature:	Part No.	Date Issued:	Approved by:
Product Nomenclature:	Next Assy. No.	Date Approved:	Prepared by:

Flow No.	Process			Control Item			Responsible Personnel			
	Process Flow by Graph, Symbol	Kinds of Operation	Tool & Machine	Control Item	Standard Value	Production Standard	Section Chief	Eng'r	Foreman	Asst. F'man
1	○	Main-Shaft, Rough Machin.	#1 Lathe	Outside Ø	$Ø = 50 \pm 0.1$	$Ø = 50 \pm 0.1$				○
2	○	Mid-Section, Machining-Lathe	#5 Lathe	Outside Ø, Mid-Sect.	$Ø = 20^{-0.050}_{-0.080}$	$Ø = 20.5^{+0.1}_{0}$				○
3	○	Pin, Machining-Lathe	#1 Milling	Outside Ø, Pin	$Ø = 15^{0}_{-0.025}$	$Ø = 15.9^{+0.1}_{0}$				○
4	○	Transport to Grinding Shop								
5	○	Main Shaft	#1 Grinding	Outside Ø	$Ø = 20^{-0.055}_{-0.059}$				○	
6	○	Mid-Sect Grind, Pin Grinding	#2 Grinding	Outside Ø, Pin	$Ø = 15^{0}_{-0.020}$				○	
7	□	Inspection	#2 Insp. Stn.			If strict control is necessary, specify.		○		
8	○	Transport to Buffing								

Rev. No.	Date	Revision Reason	Issued by	Appvd. by	Rev. No.	Date	Revision Reason	Issued by	Appvd. by	Rev. No.	Date	Revision Reason	Issued by	Appvd by.

8. EXAMPLES OF STANDARDS

A) Clerical office standards

(1) GENERAL AFFAIRS : INHOUSE REGULATION & STANDARD CONTROL
NEW PRODUCT DEVELOPMENT
CUSTOMER CLAIM & COMPLAINT HANDLING
QUALITY CONTROL
PRODUCT SPECIFICATION

(2) ORGANIZATIONAL : ORGANIZATION, JOB ASSIGNMENT, RESPONSIBILITY, AUTHORITY, & ROLE
COMMITTEE RESPONSIBILITY & ROLE

(3) PERSONNEL : WORK REGULATION, QUALIFICATION , EDUCATION & TRAINING, CERTIFICATION, PROMOTION, WAGE, REGULATION

(4) FINANCE : BUDGET, INVESTMENT, COST ESTIMATION, BALANCE SHEET PREPARATION, ACCOUNT SETTLEMENT, REGULATION

(5) PROCUREMENT : SUPPLIER CONTROL, PROCUREMENT SPEC, PROCUREMENT OFFICE WORK, COST CONTROL, SUPPLIER SURVEY, RATING, DELIVERY CONTROL

(6) MARKETING : SALES PREDICTION, CUSTOMER HANDLING, CUSTOMER INFORMATION FEEDBACK, MARKET SURVEY INFORMATION, WARRANTY CLAUSE, MARKET ANALYSIS, COMPETITIVE PRODUCTS SURVEY

B) Production related standards

(1) PRODUCT QUALITY SPECIFICATION

(1-1) END-PRODUCT QUALITY SPECIFICATION

(1-2) IN-PROCESSING COMPONENT QUALITY REQUIREMENT

(1-3) SAMPLING PROCEDURE

(1-4) QUALITY CHARACTERISTICS MEASUREMENT PROCEDURE

(1-5) TESTING METHOD AND ACCEPT OR REJECT CRITERIA

(2) RAW MATERIAL SPECIFICATION

(2-1) DIRECT RAW MATERIAL SPECIFICATION

(2-2) AUXILIARY MATERIAL SPECIFICATION

(2-3) SHELF-ITEM PROCUREMENT SPECIFICATION

(2-4) SUB-CONTRACTING ITEM SPECIFICATION

(3) Test and Inspection Standard

(3-1) Testing Method Standard

(3-2) Testing Measurement Standard

(3-3) Instrument Control Procedures for Testing Equipment

(3-4) Sampling Procedure for Test & Inspection

(3-5) End-Item Final Inspection Procedure & Its Criteria

(3-6) Inprocess Inspection Procedure & Its Criteria

(3-7) Identification & Disposition Procedures for Acceptance, Rejection or Condemnation

(3-8) Special Inspection Procedure & Its Criteria

(3-9) Inspection Equipment Control Procedure

(3-10) Material Review Procedure

(4) Engineering Standard

(4-1) Engineering Processing Standard such as Conceptual, System & Detail Design Phases

(4-2) Intrinsic Engineering Principle Standard — (Mechanical, Electrical, Hydro, Etc.)

(4-3) Design Review Procedure

(4-4) Design Process Control Procedures (Time, Cost Manpower, Etc.)

(4-5) Inprocess Standard (HT. Plating. Soldering, Brazing, Welding, Etc.)

(4-6) Weight-Control Standard

(4-7) Cost-Control Manual

(4-8) Checking-Procedure Standard

(4-9) Engineers Qualification & Certification Standard

(4-10) Engineering Management System Standard

(5) Drafting Manual

(5-1) Drawing Preparation Manual (Drawing Material, Size, Etc.)

(5-2) Drawing Numbering Procedure

(5-3) Drawing Releasing, Issuing, Distribution, Revision, Etc. Procedures

(5-4) Drawing Up-Dated Distribution Procedure

(5-5) Master Drawing Filing Manual

(6) New Product Development Standard

(6-1) New Product Development Decision Procedure

(6-2) New Technology Implementation Procedure

(6-3) Market Study and Analysis Procedure

(6-4) New Design Technology Implementation Procedure

(6-5) New Product Development Time-Span & Cost Control Procedures

(7) Standardized Component/Part Standard

(7-1) Standardized Component/Part Establishing Standard

(7-2) Selection Standard of Standardized Component/Part

(7-3) Standardized Component/Part Specification

(7-4) Sustaining Standard of Component/Part Specification

(8) Operation Standard

(8-1) Process Operation Standard in Production Phase

(8-2) Process Operation Standard in Utilization Phase

(8-3) Operation Instruction at Production Control Office

(8-4) Operation Instruction at Man-Hour Control Office

(8-5) Operation Instruction at Procurement Office

(8-6) Operation Instruction at Budgeting Office

(8-7) Operation Instruction at Cost Accounting Office

(8-8) Operation Instruction at Personnel Office

(8-9) Operation Instruction at Administrative Office

(8-10) Format Control Standard

(8-11) Industrial Safety Standard

(8-12) Hygiene Control Standard

(8-13) Energy Control Standard

(8-14) Education & Training Manual

(8-15) Process Instruction for Sampling

(8-16) Measurement Standard

(8-17) Calibration Specification for Test & Inspection, and Operation Equipment

(8-18) Claim & Complaint Handling Instruction

(8-19) Warranty & Guaranty Policy & Handling Instruction

(8-20) Contract and Purchase Order Handling Procedures

(8-21) Market Survey Instruction

(8-22) Market Research Instruction

(8-23) Operation Instruction at Sales and marketing Office

(8-24) Public Relations Manual

(8-25) General Advertising Control Instruction

(8-26) Sales-Campaign Manual

(8-27) Stock or Inventory Control Standard

(8-28) Operation Instruction at Logistic Office (Warehouse, Transport, Crating)

(9) Specific Function Managing Standard

(9-1) Ethical Code Instruction

(9-2) Various Committees' Management Regulation

(9-3) Employees (Including Management) Job Description (Role, Responsibility & Authority)

(9-4) Wage System Standard

(9-5) Promotion System Standard

(9-6) Personal Recruiting & Promotion Standard

(9-7) Education & Training Standard

(9-8) "Management by Policy" Instruction

(9-9) QC Circle Implementation Instruction

(9-10) TQC Implementation Instruction

(9-11) Organization & Personnel Assignment Regulation

(10) "Standards" Controlling Procedure

(10-1) Company's Regulation & Rule

(10-2) Standard & Specification Establishing Regulation

(10-3) Standard & Specification Approval Procedure

(10-4) Standard & Specification Issuance, Distribution, Revision, Rescinding, Auditing, Master Filing, Etc. Procedures

(C)T Q C RELATED STANDARDS (Examples)

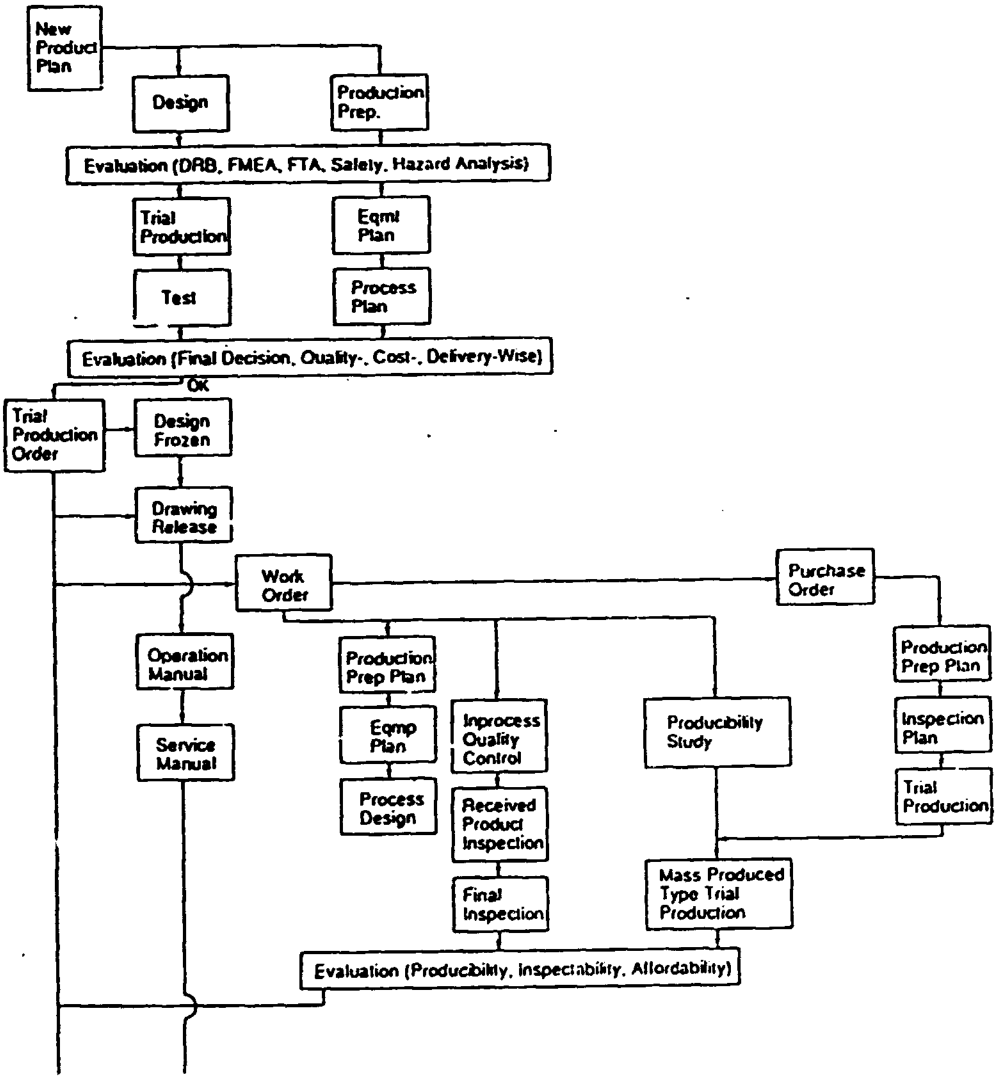
Basic Regulation: Creed, the Article of Association, Board Meeting

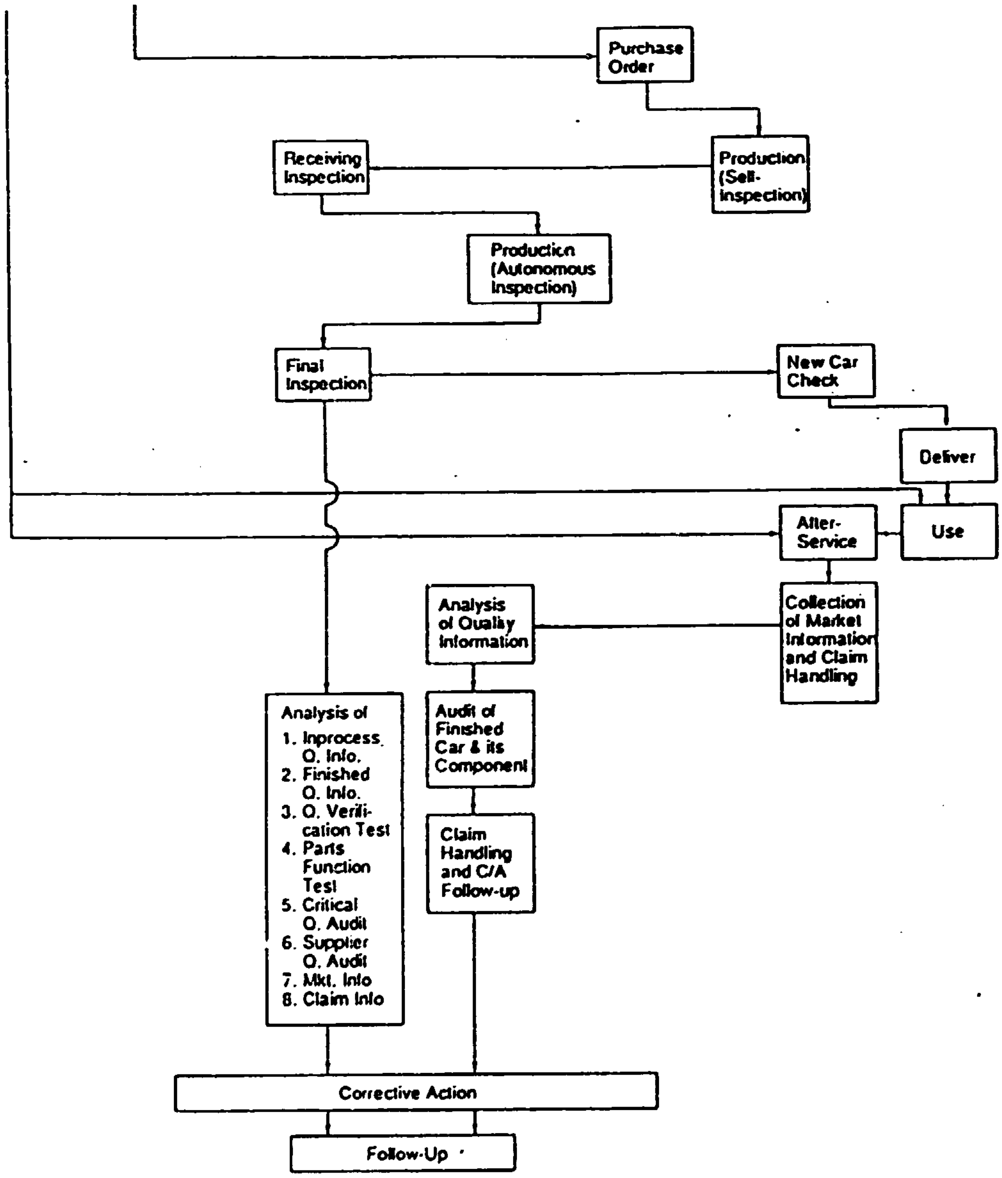
CONTROLLING RULE	ORGANIZATIONAL RULE	GENERAL	Organization Control	Organization & Functional Control
			Job Assignment & Authority	Job Description, Ringi System, Office Responsibility.
			Committee, Meeting	Meeting, Functional Committee, TQC Steering Committee, New Product Development Committee
			TQC Organization & Delegation	TQC office, TQC Promotion Plan, TQC Management
	WORK CONTROL	GENERAL CONTROL	Quality Control–General	Quality Control
			Management by Policy	Management by Policy, Routine Control
			Management by Function	Quality Assurance, Quantity Control, Cost Control
			Controlling Flow Chart	Management by Policy, Quality Assurance, Quantity Control, Cost Control
			Education & Training	In-House Education & Training
			Standardization	Standardization, Rule & Regulation Control, Std. Spec. Control
			TQC Audit	TQC Audit QC Diagnosis
		BY STAGES	Investigation	Quality Information Collection, Market Surveying, Competitive Product Investigation, Quality
			Research & Development	Analysis, Demand Forecasting, New Product Development Control, Newly Developed Product Evaluation, New Product Developing Cost Control

CONTROLLING RULE	WORK CONTROL	QUALITY ASSURANCE	BY STAGES	Planning	New Product Planning, New Process Planning
				Design	Design Review, Quality Deployment Drawing Control
				Procurement	Supplier Control, Subcontractor Control, Supplier Rating System, No-Inspection System
				Production	Production System, Production Control, Control-Chart Utilization Process Capability Control, Failure Report System, In-process Control, Plant Experiment, Self-Inspection System
				Shipment Store	Shipping Quality Level Control, Transportation Control, Storage Control, Corrosion Control
				Sales & Service	Marketing Control, Initial Product Control, Tech Service Control, Claim & Complaint Handling, Recall Procedure, Product Survey in Market Procedure, Customer Information Treating
			BY FUNCTIONAL	Inspection	Initial Processing & Finished Products, Inspection – Inprocess, Receiving & Outgoing, Inspection Record Reviewing Procedures
				Quality Audit	Periodic Audit Planning, Market Quality Evaluation, Long-Life Product Quality survey, Critical Quality Problem Treating Procedure
				Equipment	Equipment Maintenance, Equipment Procurement Procedure, Calibration
				Energy	Energy Control Procedure

CONTROLLING RULE	WORK CONTROL	QUALITY ASSURANCE	BY FUNCTIONAL	Quality Info Equipment	Quality Info Equipment Control. Calibration Control
				Safety	Safety & Sanitation Control
				Pollution	Environment Protection Control, Pollution Prevention Control
				Suggestion System	Suggestion System Control, Awarding System
				Office Work Control	Office Work Improvement, White Color Productivity Measurement
				QC Circle	People Building, Evaluation System, Rewarding System

D) Flow Chart (Example) for New Product Development




Purchase Order
Production (Self-Inspection)
Receiving Inspection
Production (Autonomous Inspection)
Final Inspection
New Car Check
Deliver
Use
After-Service
Collection of Market Information and Claim Handling
Analysis of Quality Information
Audit of Finished Car & its Component
Claim Handling and C/A Follow-up
Analysis of
1. Inprocess Q. Info.
2. Finished Q. Info.
3. Q. Verification Test
4. Parts Function Test
5. Critical Q. Audit
6. Supplier Q. Audit
7. Mkt. Info
8. Claim Info
Corrective Action
Follow-Up

9. STNDARDIZATION FOR NON–CLERICAL OFFICE

STANDARDIZATION

9–1. organization

EFFECTIVE MANAGEMENT FOR QUALITY MUST BE CLEARLY PRESCRIBED THRU CUSTOMER REQUIREMENT (FOR EXTERNAL CUSTOMER) / DUTY ASSIGNEMENT (FOR INTERNAL CUSTOMERS) BY EVERY MANA–GEMENT ASSIGNED.

EMPLOYEES PERFORMING QUALITY FUN–CTION MUST HAVE SIFFICIENT, WELL–DEFINED RESPONSIBILITY, AUTHORITY AND THE ORGANIZATIONAL FREEDOM TO IDENTIFY AND EVALUATE QUALITY PROBLEMS AND TO INITIATE, RECOM–MEND OR PROVIDE SOLUTIONS. MANAGE–MENT REGULARLY ARE NECESSARY TO REVIEW THE STATUS AND ADEQUACY OF THE QUALITY PROGRAM.

9-1-1 organization assessment

A. DOES THE ESTABLISHSED PROGRAM IDENTIFY THE ORGANIZATIONAL ELEMENT RESPONSIBLE FOR EACH OF THE VARIOUS QUALITY EFFORTS

B. DO THE EMPLOYEES PERFORMING THE QUALITY FUNCTION HAVE SUFFICIENT AUTHORITY, RESPONSIBILITY, AND FREEDOM OF ACTION TO IDENTIFY AND EVALUATE QUALITY PROBLEMS AND INITIATE, RECOMMEND, OR PROVIDE SOLUTIONS ?

C. DOES MANAGEMENT PERIODICALLY REVIEW THE STATUS, TRENDS, AND ADEQUACY OF THE QUALITY PROGRAM, THAT IS, RESULTS OF PERFORMANCE AND FUNCTION ACHIEVED AND STANDARDS EFFECTIVENESS ?

9–2. initial quality planning

EVERY MANAGEMENT ARE NECESSARY TO CONDUCT COMPLETE REVIEW OF CUSTOMER OR OWN'S DUTY REQUIRE–MENTS TO IDENTIFY AND MAKE TIME–LY PROVISION FOR THE SPECIFIC CONTROLS, PROCESSES, TEST EQUIP–MENTS, FIXTURES, TOOLING AND SKILL REQUIRED FOR ASSURING QUALITY THIS INITIAL PLANNING WILL RE–COGNIZE THE NEED AND PROVIDE FOR RESEARCH, WHEN NECESSARY, TO UP–DATE ASSURING PROCEDURES SUCH AS CHECKING, INSPECTION AND TESTING METHODOLOGY, INSTRUMENTATION, AND CORRELATION OF INSPECTION AND TEST RESULTS WITH OPERATING ME–THODOLOGY AND PROCEDURES.

THIS PALNNING ARE ALSO COVERING APPROPRIATE REVIEW AND ACTION TO ASSURE COMPATIBILITY OF PRODUC–TION, OPERATION, CHECKING, INSPEC–TION, TESTING, AND DOCUMENTATION.

ONE OF THE MAIN OBJECTIVES OF THE INITIAL PLANNING IS TO IDEN–TIFY ANY SPECIAL REQUIREMENTS.

9-2-1 initial planning assessment

A. DO EVERY MANAGEMENT CONDUCT A COMPLETE REVIEW TO IDENTIFY AND PREPARE FOR SPECIFIC OR UNUSUAL CUSTOMERS OR DUTY REQUIREMENTS ?

B. DO EVERY MANAGEMENT PERFORM INITIAL QUALITY PLANNING AS EARLY AS POSSIBLE ?

C. DO PLANNINGS CONDUCT ANY SPECIAL STUDYING AND RESEARCH NEEDED FOR DEVELOPING EVERY NECESSARY ADVANCED OR INNOVATED CHECKING, INSPECTION OR ASSURING TECHNIQUES IDENTIFICATION ?

D. HAS ANY ACTION BEEN TAKEN TO MAKE THE CONTROL FOR SPECIFC REQUIREMENTS COMPATIBLE THRUOUT EVERY PROCESSINGS ?

9–3. OPERATION INSTRUCTIONS

THE QUALITY PROGRAM MUST ASSURE THAT ALL WORK AFFECTING QUALITY FOR HARDWARE, SOFTWARE AND HUMAN-WARE ARE SPECIFICALLY PRESCRIBED BY CLEAR AND COMPLETE DOCUMENTED INSTRUCTIONS OF A TYPE APPROPRI-ATE TO THE ENVIRONMENT AND CIR-CUMSTANCES. SUCH INSTRUCTIONS ARE NECESSARY TO PROVIDE THE CRITERIA FOR PERFORMING THE OPERATIONS AND MUST BE COMPATIBLE WITH ACCEPTAN-CE CRITERIA FOR WORKMANSHIP.
THE INSTRUCTIONS ARE INTENDED TO SERVE FOR SUPERVISING, CHECKING, INSPECTING AND MANAGING FUNCTION. THE PREPARATION AND MAINTENANCE OF AND COMPLIANCE WITH OPERATION INSTRUCTIONS ARE REQUIRED TO BE MONITORED AS A FUNCTION OF " QUALITY " PROGRAM.

9-3-1 OPERATION INSTRUCTION ASSESSMENT

A. ARE DOCUMENTED OPERATION INSTRUCTIONS AVAILABLE AND USED FOR ALL WORK OPERATIONS WHICH AFFECT QUALITY ?

B. ARE SUCH OPEATION INSTRUCTIONS COMPLETE AND APPROPRIATE ?

C. ARE COMPARISON STANDARDS SERVED AS THE QUALITATIVE CRITERIA AVAILABLE FOR EACH OPERATION WORK-SHOPS ?

D. ARE OPERATION INSTRUCTION COMPATIBLE WITH ASSOCIATED OR RELATED OPERATIONS (UPPER OR DOWN STREAM WORK-SHOPS) ?

E. DO EVERY OPERATORS, SUPERVISORS AND MANAGERS MAKE PROPER USE ?

F. ARE INSTRUCTION REVIEWED ON A SYSTEMATIC BASIS ACCURACY, COMPLETENESS AND COMPLIANCES ?

9–4. RECORD

EVERY MANAGEMENT ARE NECESSARY TO MAINTAIN AND USE ANY RECORD OR DATA ESSEBTIAL OT THE ECONOMICAL AND EFFECTIVE OPERATION OF THEIR QUALITY PROGRAM.
RECORDS ARE CONSIDERED ONE OF THE PRINCIPLE FORMS OF OBJECTIVE EVI-DENCE OF QUALITY THAT THE QUALITY PROGRAM ARE NECESSARY TO ASSURE FOR RECORDS ARE COMPLETE AND RE-LIABLE ENOUGH FOR HIGH CONFIDENCE LEVELS.
INSPECTION, TESTING, AND CHECKING RECORDS ARE, AS A MINIMUM, INDICATE THE NATURE OF THE OBSERVATIONS TOGETHER WITH NUMBER OF OBSERVA-TIONS MADE AND THE NUMBER AND TYPE OF DEFICIENCIES FOUND.
ALSO, RECORDS FOR MONITORING WORK PERFORMANCE AND FOR ASSURING WORK ARE INDICATING THE ACCEPTABILITY OF OPERATION AND OUTPUTS AND ACT-ION TAKEN IN CONNECTION WITH DE-FICIENCIES. THE QUALITY PROGRAM ARE PROVIDING FOR THE ANALYSIS AND USE OF RECORDS AS A BASIS FOR MANAGEMENT ACTION.

9-4-1

RECORDS ASSESSMENT

A. ARE THERE RECORDS OF ALL ESS-ENTIAL ACTIVITIES ?

B. ARE RECORDS AVAILABLE TO ANY NECESSARY ORGANIZATIONS FOR REVIEWAL OR EVALUATION ?

C. ARE THERE EFFECTIVE MEANS FOR ASSURING THE CURRENCY, COMPLE-TENESS, ACCURACY AND OPERATORS COMPLIANCY OF RECORDS ?

D. DO QUALITY ASSURANCE RECORDS INCLUDE ONLY THE NUMBER AND KIND OF DEFECTIVES ?
IS OTHER ESSENTIAL DATA RECORD-ED ? HOW AND WHERE ?

E. DO QUALITY ASSURANCE RECORDS AND OPERATION INSTRUCTION COM-PLIANCE RECORDS INDICATE THE QUANTITATIVE DEGREE OF ACCEPT-ANCE OR REJECTION ?

F. IF REJECTION IS RECORDED, DO RECORDS SHOW RESULTING ACTION?

G. DO MANAGEMENT ACTIONS REFLECT THE ANALYSIS & USE OF RECORD ?

Product Liability

Mr. Ichiro MIYAUCHI

(Counselor, J.U.S.E.)

Union of Japanese Scientists and Engineers

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JUSE TQC SEMINAR
FOR
BRZILIAN FACILITATORS

UNION OF JAPANESE SCIENTISTS AND ENGINEERS
(NIPPON KAGAKU GIJUTSU RENMEI)
5–10–11,Sendagaya, Shibuya–ku, Tokyo, Japan

Product liability

1. Definition of Product Liability

Products liability is the legal obligation of a manufacturer of seller for the medical expenses, lost wages, suffering, and other damage to persons who have been injured, or whose property has been damaged, as a result of a defective product, or representations about that product by a manufacturer or vendor.

2. Kinds of Product Liability

① The theory of negligence examines the conduct of the defendant in light of what society reasonably expects of him in a given situation: — Design / Production / Warning

② Strict liability and implied warranty examines the quality of the product and any defects of manufacture or design which make it either dangerous to the user and third parties or unfit for its intended use;

③ Express warranty and misrepresentation compare explicit Statements made by the defendant about the product's performance with the actual performance of the procuct.

3. Warranty

A warranty is a promise by a person selling an item that the item will meet certain standards of performance. If the item fails to live up to that standard of performance, the person who made the promise is liable to the harm caused to the buyer. Originally, the manufacturer or seller was liable only to the buyer himself, and not to other users of the product. However, in 1932 this rule was changed by the case of Baxter vs. Ford Motor Co.. In that case, the Ford Motor Express Warranty.

(A) Express Warranty

Express Warranty is simply a promise made either in writing or orally by the seller to the buyer, respecting the performance of the item sold. This promise may be made by a manufacturer or seller, in product labels, or in the seller's advertising or promotional literature. While the courts recognize that a certain amount of exaggeration is normal in a sales transaction, assertions of fact, especially dealing with the safety of the product, will be found to constitute a promise to the buyer.

If the manufacturer knows that the statements are false at the time he makes them, and also that the plaintiff will rely on them, and the plain-tiff does, in fact, rely on them and is thereby harmed, the manufacturer or seller will have to pay the plaintiff for that harm. In addition, the court may force that manufacturer of seller to pay the plaintiff an amount, known as "punitive damages", sufficient to deter that manufacturer or seller, as well as other like them, from engaging in such conduct in the future.

(B) Implied Warranty

By the very fact of placing an item on the market, the manufacturer is presumed to have promised potential buyers that the product will meet certain minimum qualifications such as its fitness for its intended use. Originally, only the buyer could sue the manufacturer or seller when a product proved to be unfit for its intended use.

4. NEGLIGENCE

Negligence is conduct which involves an unreasonably great risk of causing damage or which falls below the standards established by law for the protection of others against unreasonably great risk of harm. To make out a case in negligence, it is not necessary for the plaintiff to establish that the defendant either intended harm or acted recklessly in bringing about the harm. This theory requires only that the conduct of the defendant be measured against the standard of what a "reasonable person" would do under similar circumstances. It is for the jury to decide what the "reasonable person" would do.

For example, a soda pop bottle that exploded due to a flaw in the glass may be defective. It does not necessary follow that the defendant manufacturer of the bottle is negligent. If the manufacturer took "reasonable care" as demonstrated by the level of his quality control techniques, his conduct was not unreasonable, even though the product that came off the assembly line was in fact defective and caused injury to the plaintiff.

The court considers three factors in determining whether the defendant's conduct meets the "reasonable person" standard. The court balances the probability of the harm occurring with the seriousness of the harm, against the burden of guarding against the harm. Thus, the more remote and improbable that the defendant's conduct will result in harm, the less reason he has to protect against it. If, however, the harm can result in serious injury, the actor must consider the serious implications of even improbable or unlikely harm.

Finally, these two factors must be weighed against the burden of preventing the harm. Thus, in the exploding soda pop bottle case, on the assumption that more exacting inspection techniques existed at the time of the manuacture, it still must be determined whether the cost of instituting such procedures would have been justified. The differences in the costs of the alternative procedures must be weighted against the increased probability of discovering flawed battles through the more sophisticated inspection techniques, as well as against the seriousness of the injury that can occur from exploding pop bottles. Thus the negligence principle admits the existence of real risks associated with product use. The basic question is whether the risk is justified in the particular case.

In determining whether a manufacturer's conduct meets the " reasonable person " standard, the jury looks to the technology and information available to the manufacturer at the time of production of the particular product. However if technology or information was availabie to the manufacturer, and the manufacturer although he did not know about the new methods, should have known about them, he may be liable. It is clear therefore that the reasonable manufacturer is expected to maintain an awareness of industry wide standards and improving technology.

Conversely, an entire industry may be found negligent for the continuation of unacceptable standards of manufacture. In one case, a boiler exploded, injuring a plaintiff. The boiler manufacturer had used a hydrostatic test to establish boiler integrity. The plaintiff contended that the manufacturer should have used a more sophisticated test which had been developed by a professor of metallurgy not long before the production of the particular boiler. The professor's test had a higher probability of discovering flaws in the metal. The jury found that a reasonable manufacturer would have used the new test. The defendant therefore was liable to the plaintiff for his injuries.

Since ... determination of whether the manufacturer is negligent or not depends on the particular circumstances of the case, and since the " reasonable person " standard is so vague, it is very difficult to say whether or not a certain course of conduct will shield the manufacturer from liablity. It is clear from recent decisions that juries expect companies with staffs devoted to scientific research and engineering feasibility studies to thoroughly test a new product to determine whether it is dangerous under normal use, or foreseeable misuse. Even where a manufacture has met all the standards imposed by government agencies and trade associations, he may still be found negligence. These standards are often used as a " floor " or minimum for establishing " acceptable " conduct. In a 1971 case a helicopter manufacturer had met the Federal Aviation Administration' s standards for the time available to the pilot for engage in the auto-rotation control after engine failure. The court found that the jury would be permitted to find that a reasonable manufac-turer would design the control so as to allow the pilot even more time after the engine failure to activate the auto-rotation control than required by the FAA standards. It is clear, therefore, that the final responsibility for reasonable behavior rests with the manufacturer.

Manufacturers have been found negligent based on the following conduct:

(1) Improper design of products;

(2) Improper manufacture or assembly of the product;

(3) Failure to inspect and test for defects in the pre-marketing stages;

(4) Failure to warn of dangerous characteristics inherent in or built into the product;

(5) Deceptive advertising and promotion of the product;

(6) Inadequate instructions for produce use or the manufacturer's failure to foresee possible dangers.

5. Failure to Warn

Although a product may be free of manufacturing and design defects, it still may be labeled " unreasonably dangerous " and defective under certain liability in tort. This situation exists if the manufacturer or supplier of a product fails to warn unknowing users about dangers inherent in the product which the manufacturer or supplier knows or should know exists. A seller's knowledge is that of an expert, and the seller should be apprised of technological advances and scientific discoveries relating to that type of product.

(A) Warning Duty under Negligence:

The duty to warn under the theory of negligence has long been accepted not only in the current case of manufacturers, but also retail sellers with particular expertise. Although comparable, a distinction remains between the duty to warn under negligence and strict liability. The negligence theory focuses on the reasonableness of the seller's conduct and warning about the dangers of the product, while strict liability may be applicable even if the seller exercises reasonable care in preparing or marketing the product. This difference can be explained by the fact that the product may be so dangerous due to the lack of warning as to violate strict liability.

(B) Existence of the Duty:

The duty to warn derives from public policy recognizing that a user is entitled to information necessary to intelligently choose whether the benefits of a particular produt justify exposure to a potential risk of harm. Implicit in this duty is the prerequisite that the user be unaware of the dangers warned against. There is no duty when the danger is , or should be, readily apparant to the user.

So, the potential danger of firing a slingshot was so apparant that a warning was unnecessary. However although a cattle feeder was obviously dangerous, its manuf-acturer should have informed users that the machine's uncovered blades became sharper, and not duller, after use. Similarly, the California Supreme Court held that a conveyer belt manufacturer could not rely on the fact that the danger was " open and obvious " as a matter of law. Its rationale is that simply because the nature of the defect is apparent, it did not automatically prevent the product from begin unreasonably dangerous to the user or consumer.

It must be noted that the manufacturer's duty to warn may not be invoked where the product itself is allegedly defective. Thus, a rug manufacturer was not strictly liable for failing to warn a person who perished in a hotel fire of the flammable composition of the rug. No warning would have changed the quality of the fiber or rendered it safe for the ultimate user.

(C) Reicipient of the Warning:

The seller must warn foreseeable users of likely dangers that may be encountered through the normal use of the product. If there is no warning, or it it proves inadequate, the seller may face liability not only to the foreseeable user, but to those persons whom one should have anticipated would be in the zone of danger, or would come in contact with the product. However, a crane manufacturer's duty to warn about the possible dangers in the operation of his equipment was extinguished by so informing supervising engineers and technicians. A direct warning to the insured employee was not required.

Pharmaceutical companies discharge their duties to warn about prescription drug dangers by informing the attending physician. Further notice is not required because it is presumed that the patient relies on the judgement of the physician.

(D) Specificity of Warning:

The actual content of a warning that would discharge the seller's responsi-bility to the user is one that, if followed, would render the product safe for users. To fulfill this duty, the manufacturer or supplier may be required to list specific dangers inherent in the product or its use on the label.

The watchword in giving adequate warning is specificity. The following label on a can of wall sealer was deemed inadequate when the fumes from the sealer were ignited by the pilot light of a gas heater and the sealer's user was burned in the resulting conflaguration:

> " CAUTION: INFLAMMABLE MIXTURE. Do not use
> near fire or flame...Contains more than 15%
> benzol - BE WARE OF POISONOUS FUMES. "

The key question in any case which turns on the defendant's duty to warn of dangers which arise from the use of the product is the foreseeability of the danger. The courts are willing to stretch this concept to create length to allow plaintiffs to recover.

6. Foreseenable Misuse

The problem of product misuse can become a factor in a product liability action at several junctures. First, it may be argued that the injury was totally a function of the consumer's misuse of the product and that the product is reasonably safe. Thus, for example, if a geologist's hammer, intended for chipping away at small rocks, is used to pound a spike into a concrete wall, shatters, and the chips penetrate the plaintiff's eye, it may be that the hammer is not defective at all. It may be a perfectly good geologist's hammer but it has been subject to a use so inappropriate that it failed. Secondly, it may be argued that, even if the product is defective, the plaintiff's use of the product was so beyond the norm that liability should not attach.

In a 1971, Rhode Island case, Ritter v The Narragansett Electric Co., the defendant, American Motors, manufactured a small 30" gas range. The plaintiff, a 4-year old girl, was injured door and used it as a step stool to look into a pot on top of the stove. The stove tipped forward, seriously injuring the plaintiff. The plaintiff's expert testimony concluded the stove was in fact defectively designed, since the oven door could not hold the weight of 30 lbs. without tipping. Under the circumstances of this case, the issue is not whether the stove was designed improperly. If the stove had tipped because a housewife had used the open door as a shelf for a heavy roasting pan, the issue would properly be the design of the unit, since it could be argued that one of the intended uses of the door was a shelf for checking food during preparation. Here, however, the issue is whether the use of the open door as a step stool was so unforeseeable that it is not correct to asign liability to the manufacturer for the harm caused to the child. The court held that it was proper for liability to attach to the manufacturer in a case such as this.

The "foreseeable misuse" doctrine can be in a real trap for manufacturers. It is only natural to assume that misuse of a product by a plaintiff will absolve the manufacturer from liability. However, the courts in the United States have not taken this view. Thus, in the 1976 New York case, Lerced v. Auto Pak Co., the court found that the manufacturer has the duty to foresee reasonable methods of dealing with the design defect. The court distinguished reasonable methods from the normal practice of the product's users. In this case the plaintiff was poking at trash in an industrial trash compactor with a stick while the machine was in operation. The court found that the machine was defective because this poking was necessary to prevent the machine from sticking.

Methods of use of the machine which border on the rediculous may be "foreseeable" to the manufacturer if the manufacturer's representatives or engineers have knowledge of the practice. Thus, in another 1976 New York case, Micalef v. Miehle, the manufacturer of a high–speed printing press was liable to a plaintiff who put his hand into the press to remove a foreign particle while the press was in operation. A reprsentative of the manufacturer had seen the plaintiff engage in this practice earlier.

Most troublesome of all to the manufacturer are the cases that find that subsequent alteration by the plaintiff or the plaintiff's employer is a foreseeable misuse of the machine. Thus, in a 1971 California case, Thompson v. Package Machinery, the court decided that the "manufacturer may be held liable where the alteration of the machine, or its misuse by the customer, was reasonably foresee–able." The jury would determine whether or not such alteration or misuse was, in fact, foreseeable.

The case which may extend this doctrine to its absolute limits is the 1962 Michigan case of Byrnes v. Economic Machinery Co.

7. Strict Liability in Tort

(A) In the case of strict liability, the plaintiff does not have to prove negligence on the part of the manufacturer or seller, but only that the product was defective when it left the manufacturer, that the defect was a cause of the injury, and that when the injury occurred the plaintiff was using the product in a reasonable manner. Courts have been wide in the concept of strict liabilities such that it now applies to all defects whether latent or overt. For example, failure to give complete and sufficient warning, or failure to provide newly developed safety devices could make the manufacturer liable under the strict liability doctrine. On the other hand, warnings and the instructions by themselves will not absolve a manufacturer of liability if a design or manufacturing defect is found. The defect, whether or not it poses an unreasonable danger, is sufficient to impose strict liability on the manufacturer.

The differences between the negligence and strict liability theories are significant and far reaching. Fundamentally, in deciding whether a product is or is not unreasonably dangerous, the focus in strict liability is on the product and not on the conduct of the manufacturer. The shift from negligence to strict liability requires, if nothing else, that their inquiry be focused on the product and its uses and away from what the manufacturer should or should not have done or perceived.

Recall that, in regard to the exploding soda pop bottle, it was established that under the negligence theory a manufacturer could claim that his quality control techniques met the standard of reasonableness and that he should not be found liable for a flawed bottle that exploded. Under the theory of strict liability it is no defense that the manufacturer acted reasonably. If the product is in fact unreasonably dangerous or defective and it caused the plaintiff's injury, the manufacturer can be held liable. Liability will attach, even though the seller has exercised all possible care in the preparation and sale of his product, and it will be of no avail to the defendant in a production defect case to argue that better quality control procedures are prohibitively expensive.

On the other hand, if plaintiff's claim is that the defendant's product is defective because of design feature it is essential, as in the theory of negligence, to weigh the burden of protecting against the harm with the probability and gravity of the harm. In testing the design defect, then, these basic considerations – balancing the probable risk inherent in the uses of the product against this utility remain common to both the negligence and strict liability causes of action.

(B) The rule of strict liability in tort is enunciated in the Restatement (2d) of Torts Section 402A. [The Restatement (2d) of Torts is an attempt by the American Law Institute, a group of the foremost American scholars in the field of torts, to describe the theory in principles of the law involved with the recovery by persons who have suffered either bodily injury or injury to their property. This particular section has been widely quoted by the American courts.]

Section 402A. Special Liability of Seller of Product for Physical Harm to User or Consumer.

(1) One who sells any product in a defective condition unreasonably dangerous to the user or consumer or to his property is subject to liability for physical harm thereby caused to the ultimate user or consumer, or to his property, if

(a) The seller is engaged in the business of selling such a product;

(b) is expected to and does reach the user or consumer without substantial change in the condition in which it is sold;

(2) The rule stated in subsection (1) applies although

(a) The seller has exercised all possible care in the preparation and sale of his product, and

(b) The user or consumer has not bought the product from or entered into any contractual relationship with the seller.

(C) WADE THEORY

Another formulaion of the strict liability and tort theory has been made by Professor Wade in a 1973 law review article. Professor Wade described the theory of strict liability as follows:

> "The law imputes to a manufacturer or supplier knowledge of the harmful character of his product whether he actually knows it or not. He is presumed to know the harmful characteristics of that which he makes or supplies. Therefore, a product is dangerously defective if it is so harmful to persons or property that a reasonable prudent manufacturer or supplier with his knowledge would not placed it in the market."

Professor Wade lists seven considerations for determining whether the theory of strict liability applies in a given case:

(1) The usefullness and desirability of the product -- its utility to the user and to the public as a whole;

(2) The safety aspects of the product -- the likelihood that it will cause injury, and the probable seriousness of the injury;

(3) The availability of a substitute product which woud meet the same need and not be unsafe;

(4) The manufacture's ability to eliminate the unsafe character of the product without impairing its usefulness by making it too expensive to maintain its utility;

(5) The user's ability to avoid danger by the exercise of care and the use of the product;

(6) The user's anticipated awareness of the dangers inherent in the product and their avoidability, because of general public knowledge of the obvious condition of the product, or of the existence of suitable warnings or instructions;

(7) The feasibility on the part of the manufacturer, of offsetting the loss by setting the price of the product or carrying liability insurance.

(D) In summary, the theory of strict liability in tort imposes the broadest liability upon the manufacturer and suppliers. Strict quality control will minimize the manufacturer's exposure to negligence liability, and carefully worded disclaimers may be sufficient to limit the manufacturer or a seller's exposure to a warranty liability, but the manufacturer may become liable in strict liability merely for placing the product on the market in a condition which is not defective at the time but may become defective by the operation of the extern forces. It is easy to see why the greatest controversy has concerned this particular basis of liability.

8. Litigaion by Plaintiff

(A) . To make out a case of products liability, regardless of the theory of liability, the plaintiff must establish the following:

(1) The product was defective,

(2) The defect existed at the time the product left the defendant's hands,

(3) The defect caused the harm and,

(4) This harm was appropriately assignable to identified defendant.

Where the plaintiff's theory is that of negligence, he must establish, in addition to these elements, that the defendant's conduct was unreasonable.

If the plaintiff fails to establish any of these elements, he cannot recover against the defendant.

(B) Product Defect.

The plaintiff must establish in some way that the product is below acceptable standards. If a product meets all the requisite demands that society sets forth and the plaintiff is injured nonetheless, he can hardly blame the manufacturer. Thus, a knife can realistically be turned to a dangerous product, it will cut meat but also has the inherent danger of cutting human flesh. Yet no court would permit the manufacturer of a knife to be sued because the housewife is cut while preparing vegetables. The product may be considered dangerous but it is not defective.

(C) The Defect Must Exist in the Product at the Time It left the Manufacturer's Hand.

Products often lead tortured lives. Products that meet even the most demanding specifications can be used and abused so that at the time of injury they are clearly defective. But such defects cannot be automatically assigned to the manufacturer. It must be determined whether the defect was introduced into the product. Unless it is established that the defect existed when the product was in the hands of the manufacturer, liability will not attach to the manufacturer. Often structural weaknesses or design problems do not manifest themselves until the product is put to a certain use.

The mere fact that a defective did not become evedence until later does not of course, mean that the defect was not present when the product left the hand's of the manufacturer. In each case a careful factual examination must be conducted to determine whether the defect was attributable to the defendant manufacturer or seller or whether it was present in the product when it left the defendant's hand.

(D) The Defect Must Cause the Harm.

The mere present of a defect in a product at the time of injury is not enough. A defect may exist in a product but have had little or no bearing on the instrument that caused the injury. The defect may have been dormant, and the operating cause of the accident may have been human failure totally unrelated to the product. This is often very difficult to ferrit out. Sometimes after the violent event of a product accident, the product appeears defective.

(E) Is the Harm Assignable to the Defect?

Even when it is clear that the defect played a role in the injury event, it is often necessary to determine whether that role was significant in assessing the defendant's liability. Even defective products can be abused and misused beyond reason. Thus, for example, if a manufacturer sold a kitchen blender with a gross structural weakness in the glass, and the plaintiff dropped metal objects in the blender, causing the glass to shatter and injur him, it may will be argued that, defective or not, it is not fair to impose liability on the manufacturer for an injury resulting from such use. The harm is not fairly assignable to the defect is a matter of elemental justice. This issue is called the issue of " proximate cause " .

It may be argued that the blender example really illustrates misuse of the product. If the law must find some way of determining whether liability should attach to a defective product when, in addition to the defect that may have played some role in the injury-causing event, misuse occurrd as well. Here the courts must judge whether the injury that occurred is properly assignable to the defect. Thus misuse in this context is laveled by the court as the " proximate cause " .

(F) The Injury Resulted From a Use of the Product that was Reasonably Foreseeable by the Defendants.

The doctrine of foreseeability is becoming important in product liability cases, and there appears to be a trend toward contributing greater foreseeability to the manufacturers. The legal doctrine of foreseeability refers to the manufacturers liability for injuries sustained in certain unintended uses, misuses, or abnormal uses which could have been clearly anticipated by a prudent manufacturer with some degree of probability. For example, a manufacture should be able to anticipate that children, or others who cannot read or understand instructions, might somehow gain access to certain hazardous products and subject them to unintended uses. Manufacturrs must also foreseeable probable defects that could arise from the product in the long run. Since there is no uniform statute of limitations in a products liability suit as of now, a manufacturer's liability could extend throughout the products lifetime.

The plaintiff proves his case by bringing forward evidence in the form of either tangible objects such as documents or the actual defective product itself, and witnesses who either saw the accident happen or experts in the field who can offer an opinion as to the cause of the accident.

9. Product Liability Prevention

(A) Design Stage.

The legal distinction between a reasonably safe product and the unreasonably dangerous one is achieved by balancing the products utility against the potential risk of harm steming from its use. Simply put, the manufacturer's decision making, before marketing a product, ought to reflect the firm's best judgment of the balancing process. Manufacturers often seek refuge in their compliance with either industry or governmental standards. Adherence to set standards is not as important, from a negligence standpoint, it may go along way towards establishing the reasonableness of the product. In certain instances, however, both industry and governmental standards have been held by Courts to be inadequate. The willingness of the Courts to question these standards simply means the manufacturers must exercise their own best judgment about whether these standards are, in fact, adequate when design trade−offs are confronted.

Underlying the duties imposed by the Courts on manufacturers is the concept that the product must be designed for foreseeable use, not solely intended use. This means that, once the functional aspects of a product are designed, a subjective, analytical process must begin. This process must articulate the types of use and misuse the product can suffer in the hands of all who come in contact with it. This process must anticipate the hazards of risk of injury that are likely to be encountered by the users. Once this is done, the product design must be reviewd and decisions made concerning which design alteration, warnings, and instructions must be incorporated to minimize or eliminate the perceived risks of injury. The choice of materials, as well as production and inspection methods for minimizing production flaws also become an intrinsic part of the process.

To apply these concepts in a structured form, consider the following formation:

(1) Delineate the scope of each product's uses.

(2) Identify the environments within which the product will be used.

(3) Describe the user population.

(4) Postulate all possible hazards, including estimates of probability of occurrences and seriousness of resulting harm.

(5) Delineate alternative design features or production techniques, including warnings and instructions, that can be expected to effectively mitigate or limit the hazards.

(6) Evaluate such alternatives relative to the expected performance standards of the product, including the following:

a. Other hazards that may be introduced by the alternative;

b. Their effect on the subsequent usefullness of the product;

c. Their effect on the ultimate cost of the product;

d. A comparison of two similar products.

(7) Decide which features to include in the final design.

If a manufacturer's risk – utility trade–offs are to be made realistically, they must be made with the full recognition of the potential risk of liability compared with the utility and marketing the product without safety design features that would raise the cost. Unquestionably, competitive market position is important in decision making, and can influence the proces. It should not, however, be the only consideration. It is as important to consider that a Trail Court will demand to view the entire decision making process on the basis of whatever records are available at the time, and the context of any design defect litigation. Thus, the decision making process needs to be supported with documentation that elucidates the considerations underlying the product's design.

However, before recording any nonsafety analysis, in any manner whatsoever, by any member of the safety design team, or by any executive or director of the corporation, it is best to remember the lessons learned by Ford Motor Company in the Pinto cases, discussed previously. With those lessons in mind, the documentation which a Court will seek to review in determining whether a product is made in a manner which makes it unreasonably dangerous are as follows:

(1) Hazard and risk data; historical, field and/or laboratory testing, causation analysis.

(2) Design safety formulation; fault, failure modes, hazard analyses.

(3) Warning and instruction formulation; methodology for development and selection.

(4) Standards; the use of in-house, voluntary, and mandated design performance requirements.

(5) Quality assurance program; methodology for procedure selection and production records.

(6) Product's performance; reporting procedures, complaint file, follow-up data, acquisition and analysis, recall, retrofit, instruction and warning modification.

(7) Decision making; how, who, why of the process.

The existence and natures of a quality assurance program are generally inadmissible under an action in strict liability if used to demonstarate the reasonableness of the production process or the improbability that a product was devective when it left the hands of the manufacturer. But such a program, described within the context of the entire risk and utility balancing process, can highlight the attention paid by the manufacturer to all aspects of the production formulation and can have a persuasive impact on the Court's understanding of the quesion of reasonable risk. Manufacturers are held to a standard of " what they should have known " about the product. Part of the design process that should be documented is what procedures are used to identify product problems as they emerge from actual use and how those data are used in subsequent changes, in addition to triggering recall and retrofit programs.

Ultimately, it is how and why the trade-offs are made and that will govern whether the product, as marketed, was a reasonable balance of risk and utility. That can be judged only if the decision making process is clearly revealed as a senditive balancing of competing considerations. Thus, the mechanics of that decision will need to be documented.

Thorough documentation can be a two-way sword, one edge of which could be viewed as unreasonably dangerous to the manufacturer. The revelations of the trade-off and decision making process may lead to uncomfortable feelings of vulnerability. A reasonably safe product is not required to be an absolutely safe one. Society must ultimately be sensitized to the concept that reasonable risk is a fact of life. In many cases, only by leading juries through this careful decision making process will the necessity of such risk-utility trade-offs become apparent.

The manner and tone of any such documentation may become critical in a litigation context. Personnel preparing reports relating to design safety should be impressed with the realization that such reports may well be read back to a jury which has just received a detailed account of an accident involving the manufacture's product, and is probably face-to-face with the injured victim. Juries will be impressed by a manufacturer's sensitivity value of human life and health. On the other hand, as the Ford Motor Company Pinto cases clearly demonstrate, a jury may will become outraged if the manufacturer's design safety decision documentation reveals a cold, calculated, " heartless " attitude towards human suffering.

(B) Quality Control Stage

As noted above, although a strict program of control may be a defense in an action by a plaintiff based on the theory of negligence, or that plaintiff has been injured by a product which is defective by reason of manufacturing defect. However, evidence of a strict quality control program will not even be admissible under the theories of strict liability or warranty. The traditioal quality control program will minimize the manufacturer's exposure through products liability actions by insuring that fewer defective products actually reach its consumers. The manufacturer, however, should consider an effective quality control program to be one facet of a much larger and more comprehensive products liability prevention program.

Systematic products liability prevention planning sensitizes management to many potential dangers and forcing them to deal with technicalities in products safety area that might otherwise be neglected. Under such a system, product planners must familiarize themselves with the product's safety acts, safety aspets of product design, manufacturing, packaging, labeling, distribution, and advertising. They also have to track product use after saie and compile and analyze user injury statistics. Without a formal system of liability prevention, planners may not get involved in these aspects of a product. The system, thus, supplements a company's quality and reliability control programs.

Liability prevention planning also has the benefit of enabling planners to understand the consumer better. By monitoring consumer complaints, the company may be able to spot problem areas not uncovered earlier. This may lead to some derivative changes. For example, one pharmaceutical company changed the content and focus of its advertising when it was discovered that customers were misusing the product. There are three primary components to a comprehensive products liability prevention program.

Those are:

(1) A product safety committee;

(2) Periodic safety audits and tests;

(3) Contingency planning for product recall.

(1) Product Safety Committee.

The first task of a company interested in product liability prevention planning is to set up a cooporate Product Safety Committee. The primary advantages of the committee's approach is that it eliminates the individual and departmental biases, leads to joint decision making and centralizes responsibility. Since questions involving product safety are complex and varied, requiring many trade—off policy decisions in which large amounts of money are involved, it is essential that a team of high level executives be appointed to this committee. The committee should consist of the heads of the department of engineering design, purchasing, manufacturing, quality control, marketing, leagal affairs and insurance. A senior corporate official should act as the product safety coordinator.

The three primary tasks of the Product Safety Committee are as follows:

(a) Establish specific policies and procedures for the represented departments in terms of product safety.

(b) Arrange seminars and training sessions, planned and conducted by experts in the products liability area, for company personnel.

(c) Inform the executive officer of all evaluations and developments, since ultimately the head of the company is accountable for the safety of the firm's products.

(d) Establish a Safety Audit Committee.

(2) The Safety Audit

Comprehensive safety audit of both new and established products should be conducted at least twice a year. The operational steps involved in the audit may be based on the following:

(a) Product fact sheet; the product in question should be described in terms of its function and method of operation, the environment in which it is used, and the user population.

(b) Sources of failure; each functional area shoud be systematically scanned to ascertain all possible modes by which product failure might occur and render the product hazardous. Inquiry should be made into the following:

(i)Concept – The product ideas and product concepts inherently safe, or are they likely to lead to injury. Are there safety replacement products available to meet the same need? An example of a product that would fail this test is mace packaged for the consumer market (mace is a chemical spray developed by the military to ward off attacker).

(ii)Design – Could the product fail because of improper design? Will it operate safely under all environmental conditions? Are the operator's operating instructions clear? Have all specifications and standards been met? Have any new techno– logical discoveries cast doubts on the original product design or product formulation? The use of consultants from independent compliance testing laboratories and trade associations should be considered in this inquiry, because they can add a measure of objectivity in appraising the safety of designs, particularly when the company has become committed to a particular design over years of production.

(iii)Purchasing – Could the product fail because of substandard materials or components purchased from outside suppliers? Are such materials and components subjected to a rigc. ous inhouse quality control check before they are integrated into the company's product?

(iv)Procudtion – This inquiry inv..ves an analysis of the adequacy and reliability of the company's production quality assurance techniques.

(v)Packaging, Distribution and Advertising – Can a product fail or become hazardous because of improper packaging, storage or distribution? Are the instructions adequate and understand– able? Is there a potential for the advertising to mislead comsumers? Does advertising or packaging make any reference to the safety of the prod ct? Is the complete marketing effort consistent?

(vi)Customers – Are customers likely to misuse the product or parts in some abnormal use in an unintended environment?

In addition, the Safety Audit Committee should review the adequacy of the four primary types of testing:

(a) Acceptance testing: i.e., the testing of incoming raw materials and components.

(b) Conformance testing: testing for compliance with physical standards.

(c) Quality control and assurance testing: testing the production process.

(d) Performance testing: human use test, indurance, abuse and over use test, environmental stimulation tests, life cycle tests, installation tests, and warranty tests.

These tests are important in that they may lead to the discovery of patent or laten safety defects which will necessitate design changes. Again, many companies may prefer to use outside testing agencies, such as Underwriters Laboratories, to review the adequacy of their testing procedures.

c. A composite of causes of failure.

The probable cause of each failure within each functional area should be compiled and a composite list made. The purpose of this step is to how a composite combination of product, environment, and user characteristics from one or all of the functional areas can cause a product failure and pose a threat to people and property.

d. Rating the product.

The probability — frequency of actual failure is either impact of the product failure is assessed. At this point, it is essential to introduce into all reports a " human " factor that reflects the company's concern with the value of human life and health, and a sensitivity to human suffering. Any reports or memorandum of design trade-off in terms of product safety for performance or for price considerations, must not appear " coldly calculated " , or assign a dollar value to personal injury.

e. Product decisions.

The Safety Audit Committee should decided whether or not to recommend that a product be continued, dropped, or replaced. In addition, the Audit Committee should determine whether a retrofit or recall program is in order.

(3) Recall contingency planning.

Recall contingency planning divides itself into two functions:

(a) Monitoring product performance;

(b) An inter-departmental recall plan;

(1) The Product Safety Audit Committee must maintain an ongoing system to monitor complaints or product injury reports from: Consumers of the product; Outside consumer protection agencies; Salesmen, retailers or wholesalers; Outside compliance testing laboratories; Consumers Products Safety Commission and other Federal agencies; Hospitals; Insurance companies.

In addition, the Product Safety Committee must establish criteria from when a recall of a product will be necessary. The process of product recall requires fast completion of a set of activities by different functional departments. A successful recall involves effective planning and efficient implementation. The following departments must be coordinated:

(a) Manufacturing; assuming the cause of the failure in the case of a production failure.

(b) Research and development and quality control; perform quality control tests on the recalled product and suggest appropriate action for hazard and risk identification.

(c) Advertising and public relations; prepare and send out unambiguous press releases to all media about the defective product, identifying the model, serial numbers, and other particulars as clearly as possible. Customers must be informed of the proper course of action to follow. Advertisements must motivate consumers to return hazardous products.

(d) Marketing; in accurate assessment must be made of the number of defective products in the hands of consumers, middle men, salesmen, and regional distribution centers. Outside help in this regard can also be obtained from some commercial firms which have product recall task forces with the special coordinator to help client company's trace and recall product programs.

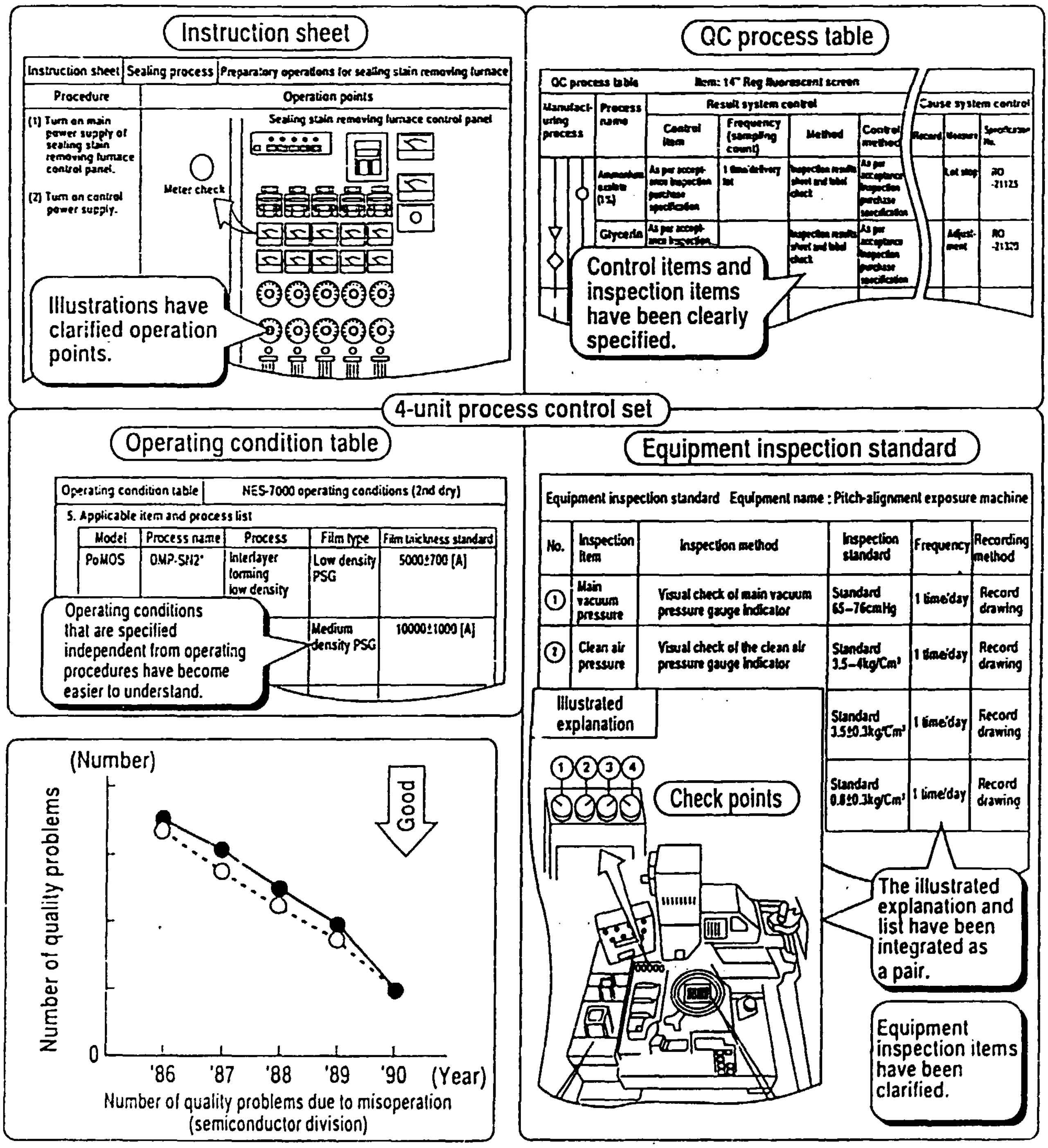
(e) Transportation and shipping; arrange for physical removal of the defective products either for destruction or salvage. Speedy removal of defective products from the channels of distribution is a key element in minizing liability. Arrangements must also be made for transporting the replacement products to the field warehouses and on to retailers and consumers.

(f) Legal staff; advise all departments concerned, including the top corporate officers, on rights and liabilities in the proper courses of action. Act as liaison between the company and any government agencies involved in the recall.

Summary of the Comprehensive Production Product Liability Prevention Program.

Increasing governmental, judicial and consumer pressures such a planning approach almost inevitable, and the use of such plans could spell the difference between a corporation's survival of failure. Product liability prevention planning is not the job of a single department, but the collective and coordinative effort of many departments. Besides reducing a company's exposure to product liability suits, the program has the benefit of diminishing the number of needless accidents and proving the overall quality of the company's product and reputation.

(3) Thoroughness of standard operations by 4-unit process control set



Number of quality problems due to misoperation (semiconductor division)

4.3 Equipment Control

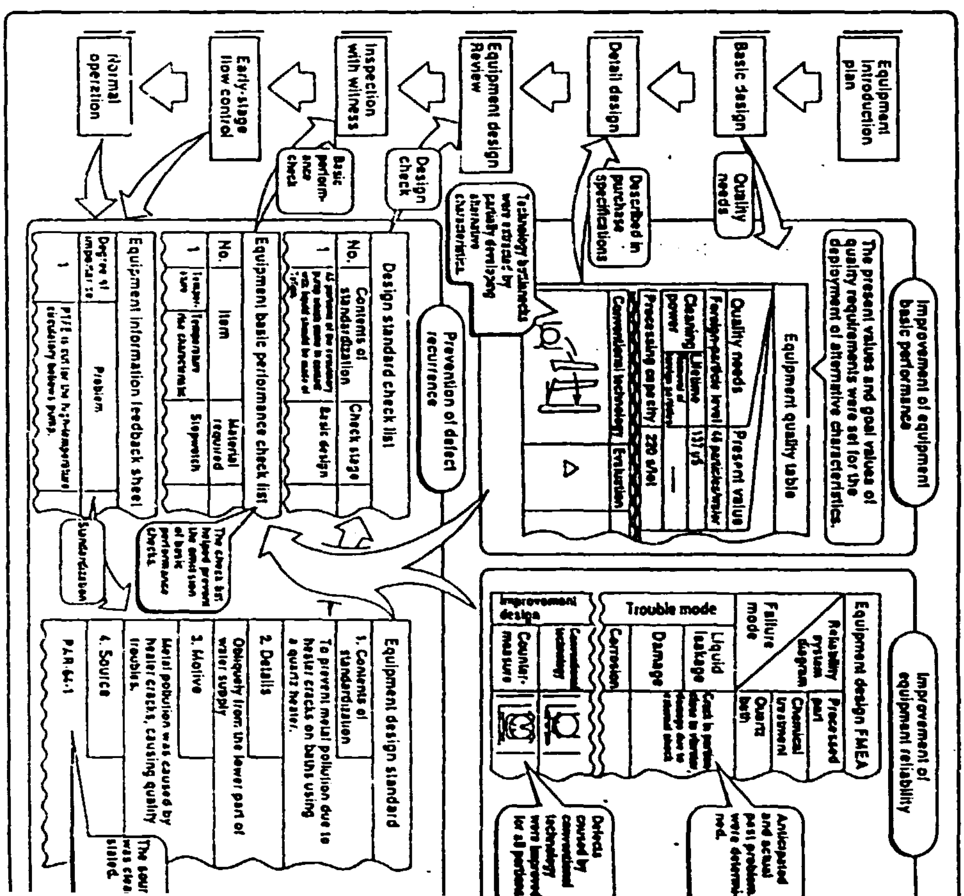
4.3.1 Basic Concept

- We shall educate our employees in the use of advanced equipment and increase productivity by improving equipment design quality and improving existing equipment.

4.3.2 Major activity and activity progress

Fiscal Year	'87	'88	'89	'90	'91
Main Items	Stable operation at an early stage by improving equipment introduction control				
	• Identification of defects by introducing the "Equipment Design Review System"	• Identification of technology bottlenecks by the "Equipment Quality Table"	• Integration of equipment introduction procedures based on the "Equipment Quality Table"	• Improved in reliability by "Equipment FMEA" • Accumulation and use of know-how by the "Equipment Design Standard"	• Improved in parts reliability by the "Weibull Probability Paper"
	Improved equipment reliability by improving of equipment maintenance activities				
	• Promotion of periodic inspection by the "Periodic Inspection Instruction Sheet"	• Improvement of routine checks by the "Equipment Inspection Standard"	• Improvement of failure-analysis capability by PM analysis	• Optimization of inspection contents by the "Periodic Inspection Effect Check Sheet"	• Equipment-caused improvement in process capacity index

(3) Improved equipment introduction procedure and design quality



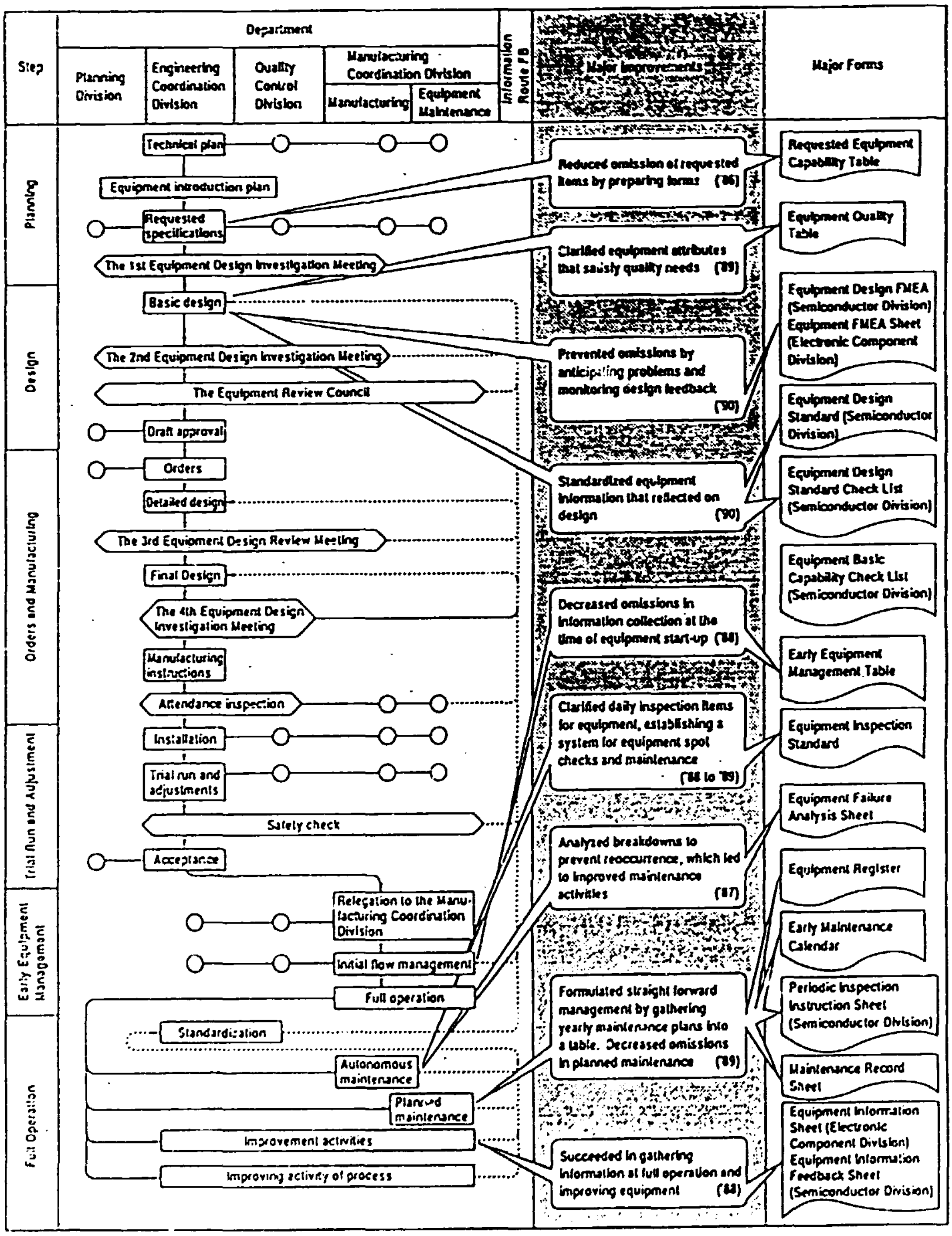


Figure Equipment Management System (Summary) c- Melhoria da credibilidade através do reforço da previsão contra reincidência

1 · Análise através do plano de solução do problema e implementação destas medidas

2 · Investigação detalhada da causa através da "Planilha de Análise do Caso"

3 · Investigação detalhada da causa através da "Planilha de Análise do Caso"

4 · Início do "Registro dos Problemas Importantes de Qualidade"

5 · Promoção da verificação da satisfação do consumidor

4.3- Controle dos Equipamentos

4.3.1- Conceito básico

Educar os nossos funcionários para uso de equipamentos avançados e incremento da produtividade através da melhoria da qualidade do projeto dos equipamentos assim como a incorporação de melhoria nos existentes.

4.3.2- Principais atividades e seu progresso

Itens Principais/Ano fiscal

a- Operação estavel num estágio preliminar através da introdução do controle de melhoria do equipamento

1 · Identificação dos defeitos através da introdução do "Sistema de Revisão do projeto do equipamento"

2 · Identificação das limitações tecnológicas através da "Tabela da Qualidade do Equipamento"

3 · Integração do procedimento de introdução do equipamento através da "Tabela da Qualidade do Equipamento"

4 · Melhoria da sua confiabilidade através de "FMEA [Failure Mode and Effect Analysis - Análise da Modalidade de Falha e seu Efeito] do equipamento".

5 · Melhoria da confiabilidade dos componentes através do "Papel Probabilistico de Weilbull"

6 · Acumulação e uso do know-how através da "Padrão de Projeto de Equipamentos"

b- Melhoria da confiabilidade do equipamento através da melhoria das atividades da sua manutenção

1 · Promoção do período de inspeção através da "Planilha de de Instrução para Inspeção Periódica"

2 · Melhoria da rotina de verificação através da "Norma para Inspeção de Equipamentos"

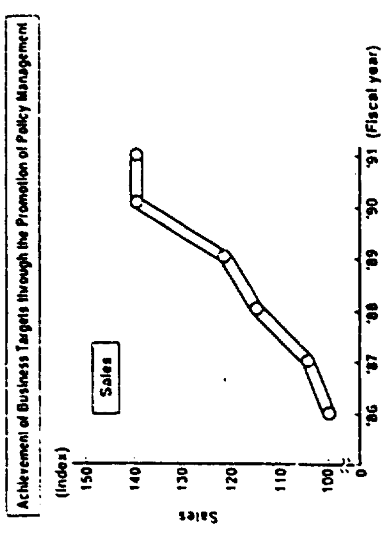
3 · Melhoria por meio da capacitação para análise da quebras através da Análise PM

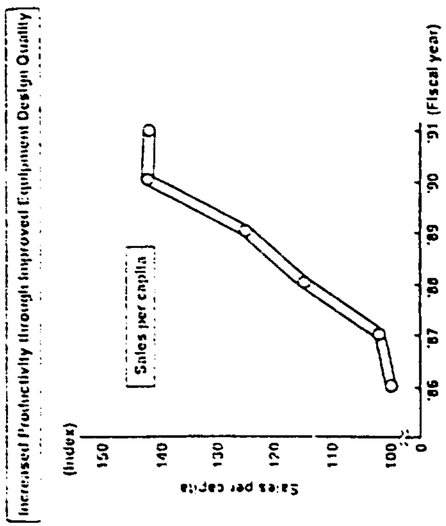
4 · Otimização do conteudo da inspeção através de "Planilha de Verificação do Efeito da Inspeção Periódica"

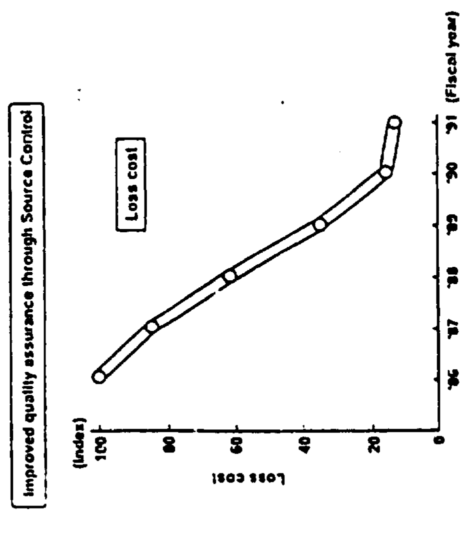
5 · Melhorias decorrentes do equipamento através do índice de capacitação do processo

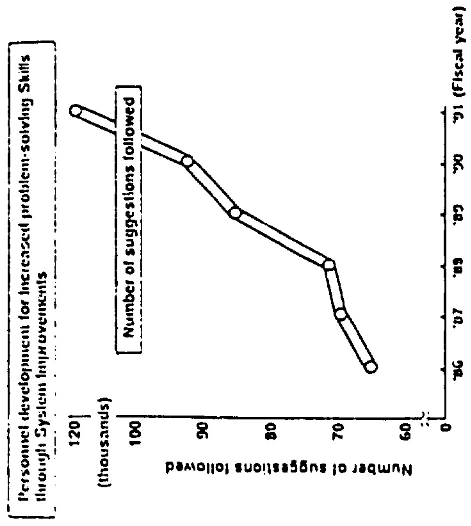
5. Overall Results

5.1 Tangible Effects









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5- RESULTADOS GLOBAIS

5.1- Resultados Tangíveis

1- Cumprimento das metas de negócios através da promoção da Gestão da Diretriz

a- vendas
b- índice
c- vendas
d- ano fiscal

2- Melhoria da produtividade através da melhoria da qualidade do projeto de equipamento

a- vendas per cápita
b- índice
c- vendas per cápita
d- ano fiscal

3- Melhoria da garantia da qualidade através de controle da fonte

a- custo da perda
b- índice
c- custo da perda
d- ano fiscal

4- Desenvolvimento pessoal através da habilidade para solucionamento dos problemas dentro do Sistema de Melhorias

a- número de sugestões acompanhadas
b- 1000
c- número de sugestões acompanhadas
d- ano fiscal

5.2 Intangible Effects

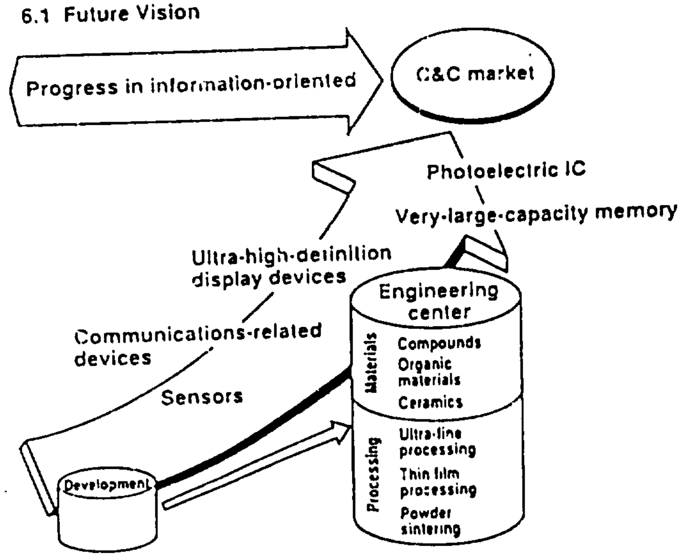
The business revolution proceeded, energizing the whole company.

Became customer oriented

Became confident in the introduction of high-tech products and equipment

6. Future Plans

6.1 Future Vision



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5.2 Efeitos Intangíveis

A revolução nos negócios se processa, energizando toda a companhia.

Postura voltada ao consumidor

Aquisição de confiança na introdução de produtos e equipamentos de elevada tecnologia

6- Planos Futuros

6.1 Visão Futura

Progresso na informação orientada   Mercado C&C

circuito integrado fotoelétrico

capacidade de memória extra larga

unidade de display de definição ultra-alta   Centro de Engenharia

Materiais formulações
materiais orgânicos
cerâmicas

unidades relacionadas com a comunicação

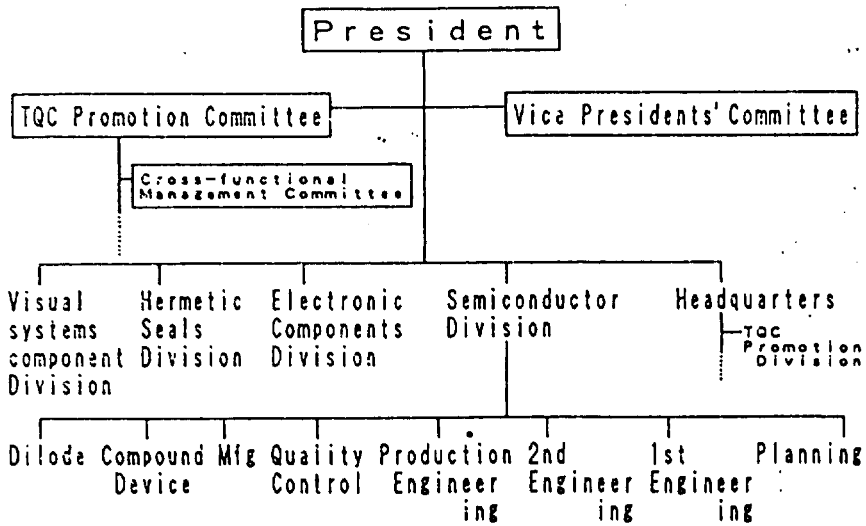
sensores

Processamento
processamento ultra-fino
processamento em filme delg
sinterização do pó

desenvolvimento

3. Promoting TQC

3. 1 (1) Organization



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(2) Main Conferences

	Designation	Frequency per mth	Chairman
company whole	Vice Presidents Meeting	2	President
	TQC Promotion	1	President
	Cross-functional Management Committee	1	B. of D. in charge
semicon Div.	Division Meeting	2	Div. Director
	TQC Promotion	1	Div. Director
	Design Reveiw	2−3	- -
	Quality Conference	2	Director Quality

block 2

3- Promoção do TQC

3.1- (1) Organização

Presidente

Comitê para Promoção do TQC

Comitês dirigidos pela Vice Presidencia

Divisão de componentes de sistemas visuais

Divisão de Selagem herméticos

Divisão de componentes eletrônicos

Divisão de semicondutores

Matriz Divisão Promoção do TQC

Diodo | Formulação | Producão | CQ | Eng. do Processo | Engenharia #2 | Engenharia #1 | Planejamento

(2) Reuniões Principais

Designação	freq/mes	presidido por
por toda a companhia		
Reunião de vice-presidencia	2	presidente
Promoção do TQC	1	presidente
Comitê de Gerenciamento de Função Cruzada	1	diretor executivo em função
Divisão de Semicondutores		
Reunião Divisional	2	Diretor Divisão
Promoção do TQC	1	Diretor Divisão
Revisão do Projeto	2-3	-.-
Simpósio da Qualidade	2	Diretor da Qualidade

3.2 Role of the TQC Promotion Center

1. It drafts proposal for the promotion of TQC.

2. It sets up plans for TQC education, QC workshops and other dissemination activities conduc'ed by experts from inside and outside the company...

3. It keeps tabs on current issues and problems in the company's policy and functional management systems.

4. It drafts diagnostic checklists for top management and functions as the secretariat when such audits are being made.

5. It keeps track of TQC results.

3.2- Papel do Centro de Promoção do TQC

1 Delineamento da proposta para promoção do TQC.

2 Planejamento para educação do TQC, disseminação atividades conduzidas por especialistas e grupo de trabal em CQ, internos e externos à companhia.

3 Manter-se alerta sobre os itens e problemas atuais dentro diretriz geral e sistema de gestão funcional da empresa.

4 Elaboração da planilha de diagnóstico da função para a direção e secretaria-los durante a auditoria a conduzida.

5 Monitorar os resultados do TQC.

Diagnosis by the President

1. Types of Diagnosis

1) Diagnosis of Policy Management (conducted semiannually)

The Diagnosis of Policy Management is a diagnosis of the soundness of management a) in the development and implementation of policy, b) in checking progress towards the attainment of goals, and c) in efforts to improve the methods used to create and implement subsequent plans and evaluate their results.

This diagnosis includes the identification of problems and issues and the provision of guidance regarding them. The diagnosis also addresses specific troubles being experienced by given departments.

2) Diagnosis of Quality Control (conducted annually)

The Diagnosis of quality Control is a diagnosis of elements which cannot be completely understood from the more narrow perspective of a single division. This is a specialized, company-wide diagnosis that cuts across division lines and focuses on new product development, quality assurance, equipment control. (This diagnosis is also called the "QC Diagnosis.")

B..ck 2 page 5/6

Diagnóstico pelo Presidente

1- Tipo de diagnósticos

1) Diagnóstico do Gerenciamento da Diretriz (conduzida semestralmente)

O diagnóstico do Gerenciamento da Diretriz constitui a fonologia da gestão:

a- no desenvolvimento e implementação da diretriz

b- verificação do progresso através do cumprimento das metas

c- a fim de melhorar os métodos atodados para criar e implementar planos subsequentes assim como avaliar os resultados.

Neste diagnóstico está incluso a identificação dos problemas e emissão das orientações relativas a sua provisão. Este diagnóstico também endereça problemas específicos enfrentados pelos respectivos departamentos.

2) Diagnóstico de Controle da Qualidade (conduzida anualmente)

O diagnóstico em Controle da Qualidade constitui o diagnóstico dos elementos que transpõe o nivel de compreensão de uma divisão.

Trata-se de um diagnóstico especializado por toda a companhia, tranpondo as linhas limítrofes de uma divisão e focaliza a garantia da qualidade, desenvolvimento de novos produtos, controle dos equipamentos, etc.

(Este diagnóstico é também conhecido como "Diagnóstico em CQ".)

2. Purpose

1) To determine whether goals are being met.
2) To improve communication between the President, heads of departments, and employees.
3) To identify what courses of action we should be pursuing as a leader in our industry, and to implement appropriate plans.

3. Results

1) The diagnoses allow top management to understand the state of affairs of the company and to respond appropriately.
2) The diagnoses provide a venue through which the thinking of top management can permeate the entire company.
3) The diagnoses improve both intercompany communication and morale.
4) The management skills of division and section manager will improve.
5) The diagnoses help to maintain and improve management tools and mechanisms.

Block 2 page 7/8

2- Propósito

1- Determinar se as metas estão sendo cumpridas.

2- Melhorar a comunicação entre o presidente, as chefias do departamentos e funcionários

3- Identificar quais os cursos de ações a serem perseguida para liderar o segmento indústrial, e implementar plano apropriados.

3- Resultados

1- O diagnóstico permite a alta direção compreender a situaçã vigente na companhia e distribuir respostas apropriada

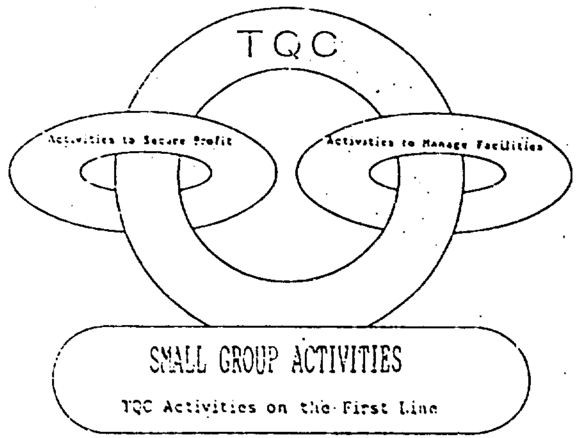
2- O diagnóstico propicia a compartilhação do pensamento d alta direção por toda a companhia.

3- O diagnóstico melhoria a comunicação e o moral por toda empresa

4- A habilidade gerencial das chefias junto as divisões seções melhoram.

5- O diagnóstico ajuda a manter e melhorar as ferramentas e o mecanismos de gestão.

SMALL GROUP ACTIVITIES IN
NEC KANSAI LTD.



Activities started in 1966. QC Circles have the history of more than twenty years and have been the driving force to achieve the PM Prize, going through from Operation Q to TQC. All circles are registered at QC Circle Headquarters and at the forefront of all the Q-up activities. Their performance have been highly recognized and received Deming Prize.

HISTORY OF SMALL GROUP ACTIVITIES IN NEC KANSAI, LTD.

Year	History
1966年（昭41）	ZD Activities starts.
1972年（昭47）	Operation-Q starts. (Seven Q-up's)
1983年（昭58）	TQC introduced throughout NEC KANSAI, LTD.
1984年（昭59）	TQC Promotion Headquarters sections (Small group activities, QA, etc.) set up. TQM-kick-off
1985年（昭60）	ZD Implementation Prize awarded (national).
1988年（昭63）	PM Prize awarded. Registration at QC Headquarters (Union of Japanese Scientists and Engineers <JUSE>) starts.
1990年（平成2）	All circles registered at QC Circle Headquarters (JUSE).
1991年（平成3）	Deming Application Prize awarded

Block 5 - page 1

Atividades dos Grupos de CCQ na *NEC KANSAI Ltd.*

TQC

Atividades para assegurar a lucratividade

Atividades para facilitar a gestão

As atividades iniciaram em 1966

Os grupos de CCQ já atuam por mais de 20 anos e constituiram a força motriz para conquista do Prêmio PM, cobrindo desde a operação Q até TQC. Todos os grupos são registrados no QG de CCQ e também como linha de frente das atividades Q-up. Os seus méritos foram reconhecidos no recebimento do Prêmio Deming da Qualidade.

page 2

Histórico dos grupos de CCQ na NEC KANSAI LTD.

ano histórico

1966 Início das atividades ZD

1972 Início da Operação Q (Seven Q-up).

1983 Introdução do TQC por toda NEC KANSAI LTD.

1984 Instalação do QG para Promoção do TQC (Grupos de CCQ, Garantia da Qualidade). Decolagem do TPM.

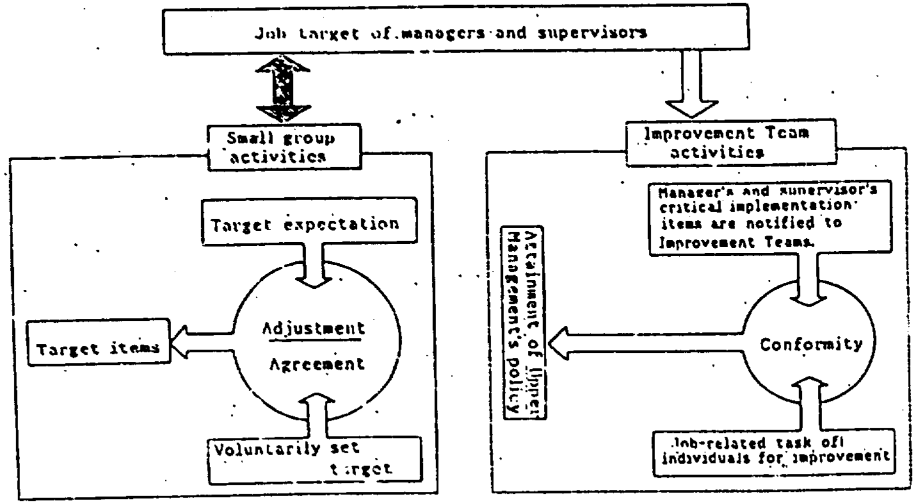
1985 Conquista do Prêmio de Implementação de ZD (nível nacional)

1988 Conquista do Prêmio PM. Inscrição junto a JUSE.

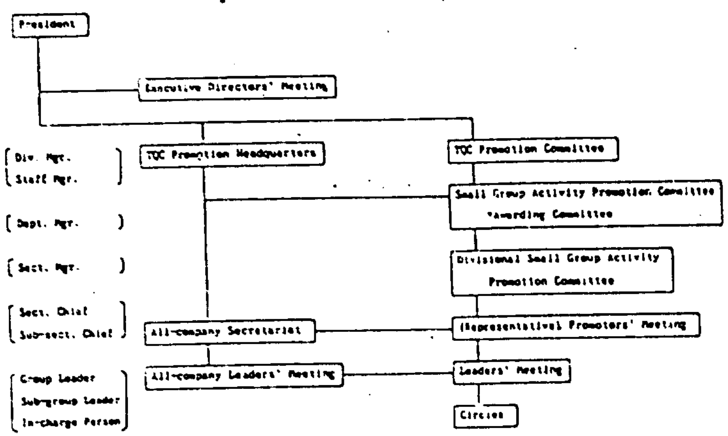
1990 Todos os grupos de CCQ são registrados junto a QG do CCQ existente na JUSE

1991 Conquista do Prêmio Deming da Qualidade

Position of Small Group Activities



Organization Chart for Small Group Activities Promotion



block 3 page 3

Posicionamento dos grupos de CCQ

Meta do Trabalho definido pelas gerências e supervisão

Grupos de CCQ

expectativa da meta

Metas

Ajustes
Acôrdos

Metas definidas voluntariamerte

Atividades dos Grupos para Melhoria

Os itens considerados prioritários pelas gerências e supervisão são comunicados ao Grupo para Melhoria

Engajamento na diretriz delineada pela alta direção

conformidade

Tarefa relacionada com o trabalho individual para melhoria

page 4

Organograma para promoção dos grupos de CCQ

Presidente

Reunião dos Diretores Executivos

Ger. Divisão Ger. Staff	QG para promoção do TQC	Comitê para Promoção do TQC
		Comitê para Promoção das atividades de CCQ
Ger. Depto		Comitê para Premiação
Ger. Seção		Comitê para Promoção de CCQ a nível divisional
Chefe Seção Sub-Chefe Seção	Secretaria por toda a companhia	Reunião dos Promotores (representação)
Líder de Grupo Líder de Sub-grupo Pessoa encarregada	Reunião de líderes por toda a companhia	Reunião de Líderes
		CCQs

The Objectives of Small Group Activities

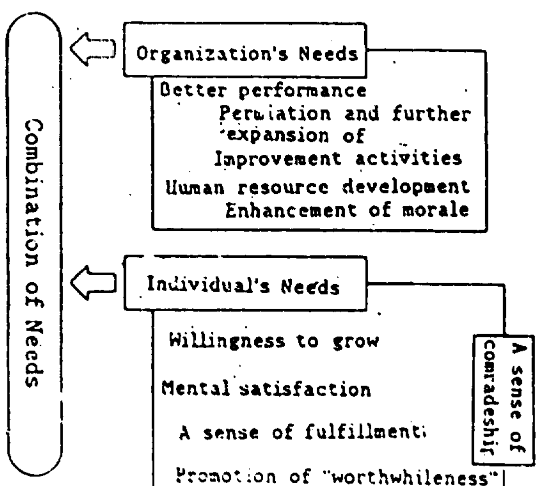
For the past twenty years or so, "ZD" has given enormous contribution to motivation for "management by objectives" and to dissemination of QC.

Circle activities starts, without using the name of "ZD"

Importance is attached to the effect of improvement activities and moreover to the members' growth through promotion of autonomous and spontaneous activities (observation in the way of QC, application of scientific method, interaction with the people involved).

Solving problems through the communicaiton with the supporters (superiors)

Why Are Small Group Activities Necessary ?



block 3 page 5

Objetivos dos Grupos de CCQs

Nos últimos vinte anos, o movimento ZD-Zero Deffect contribuiu enormemente para a motivação e "Gerenciamento por objetivos" e também na disseminação do CQ.

Os grupos de CCQ iniciaram as atividades sem adotar o nome "ZD"

Atribui-se uma importância ao esforço despreendido pelas atividades de melhoria, e principalmente para a evolução e crescimento dos membros do grupo através da promoção da atividade expontânea de forma autônoma (observando a maneira de aplicação do CQ, aplicação dos métodos científicos, interação entre as pessôas envolvidas, etc.)

Resolução dos problemas através da comunicação com os superiores

page 6

Os grupos de CCQ são necessários?

Combinação das necessidades

Necessidade da Organização

Melhor performance

Permeabilidade e maior expansão das atividades de melhoria

Desenvolvimento dos recursos human

Enaltecer o morol

Necessidade Individual

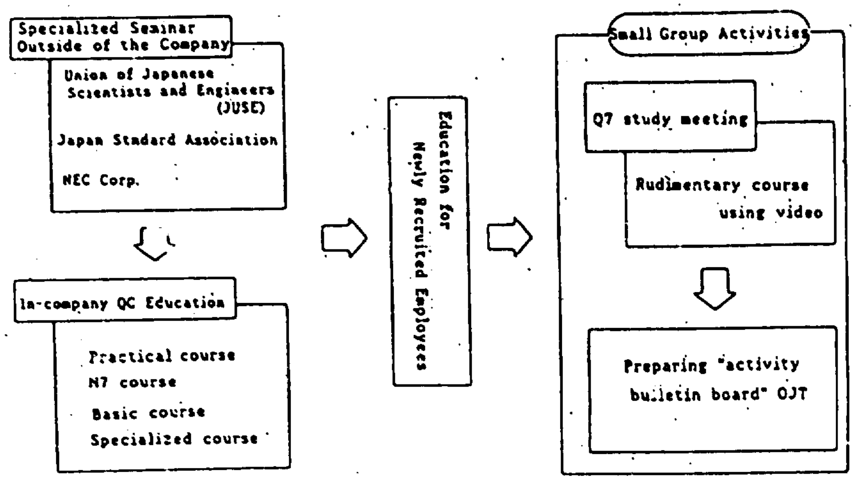
Vontade de crescer — senso de coleguismo

Satisfação mental

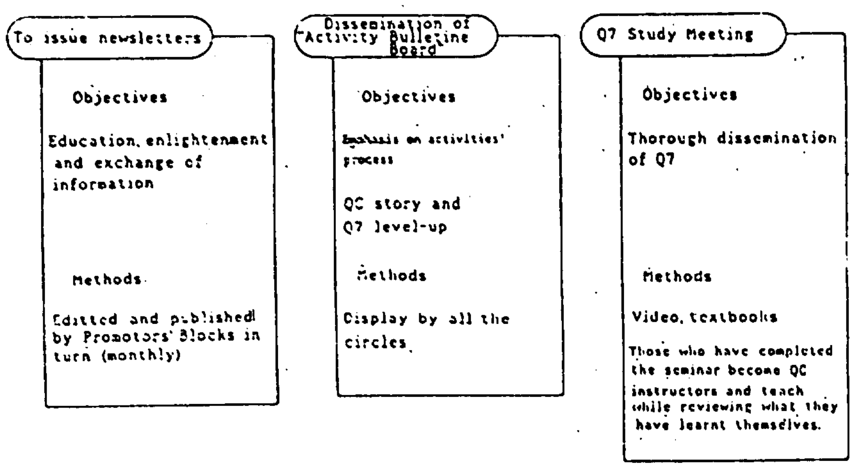
Senso de cumprimento

Promoção de "Valia"

Small Group Activities And Education



Major Supporting Activities of Promotors



Atividades de CCQ e Educação

Seminário especializado fora da Empresa

JUSE

Japan Standard Association

NEC

Educação Interna à Companhia

curso prático
curso N7

curso básico

curso especializado

Educação para recém Admitidos

Atividades de Grupos de CCQ

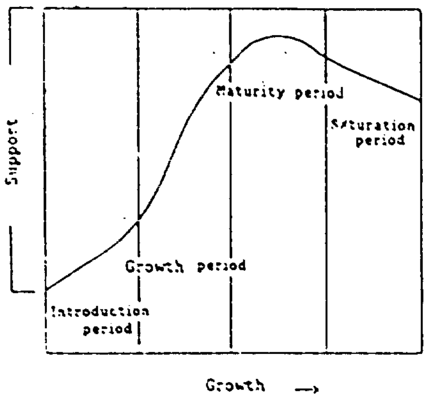
Reunião para Estudo de Q7
curso rudimentar com uso de vídeo

Preparação de OJT e de "tablóide para boletim das atividades"

Principais Atividades de Apôio

Emissão de jornais	Disseminação de Tablóide de Boletim de Atividades	Reunião de Estudo Q7
objetivos	objetivos	objetivos
Educação, esclarecimento e troca de informações	ênfase no processo das atividades história em CQ aumento de nível de Q7	disseminação de Q7
métodos	méto[illegible]	métodos
editado e publicado por grupo de promotores (em rodízio) (mensal)	mostrado a todos os grupos de CCQ	para os que concluiram o seminário e se tornaram instrutores em CQ. A revisão é feita sobre o próprio aprendizado enquanto ensina os outros.

Timing for Giving Support



Supporting based on the activities process not on the results.

Respecting autonomy

⇩

"Do this" "Do that" is overprotection.
No communication at all is too hands-off.

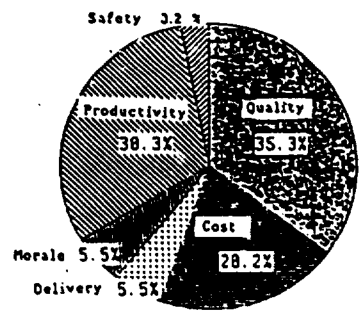
⇩

Willingness "Let's do this by ourselves."
Actual feelings "We are doing this by ourselves."

Performance Record of Small Group Activities in NEC KANSAI, LTD.

(As of April 1992)

1. Number of circles: 452 circles
2. Number of participants: 3315
3. Participation ratio: 100 %
4. Average number of circle members: 7.3/ circle
5. No. of circles per promotor: 3.7 circles/promotor
6. Types of themes: See right chart



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Oportunidade para Fornecimento de Apôio

Apôio — Período de Maturidade

Período de Saturação

Período de Crescimento

Período de Introdução

crescimento ->

O apôio não se relaciona com os resultados

Respeito a autonomia

"Faça isto", "Faça aquilo" constitui uma super-proteção
Inexistência de comunicação é uma grande lacuna.

A vontade de "Vamos fazer por nós mesmos"
Satisfação de "Estamos fazendo por nós mesmos"

Registro de Performance dos grupos de CCQ na NEC KANSAI LTD.

1- Número de Círculos: 452
2- Número de participantes: 3315
3- Índice de participação: 100%
4- Número médio de membros por Círculo: 7.3
5- Número de Círculos por promotor: 3.7
6- Tipo de temas: pelo gráfico em anexo

Segurança
Produtividade/Qualidade
Moral
Custo
Entrega

-4

MANAGEMENT BY POLICY

JANUARY 1995

I. MIYAUCHI
COUNSELLOR
J U S E

5

PRESUPPOSITION

1. ISSUANCE OF TOP MANAGEMENT COMMITMENT.

2. ENOUGH CAPABILITY FOR PROBLEM SOLVING TECHNIQUE
   --- QC STORY PROCEDURE
   --- STATISTICAL METHOD

3. ESTABLISHMENT OF QUALITY INFORMATION COLLECTING SYSTEM

4. FULL IMPLEMENTATION OF "DAILY ROUTINE-WORK MANAGEMENT" PROCEDURES

5. ESTABLISHMENT OF "MANAGEMENT BY POLICY" IMPLEMENTING SYSTEM, STRUCTURE AND MECHANISM

6. ESTABLISHMENT OF STANDARD OPERATING PROCEDURES (SOP) FOR MBP:
   -- VITAL FEW APPRECIATION CONCEPT
   -- CATCH-BALL CONCEPT BETWEEN HIGH AND LOWER ECHELONS
   -- FULL COORDINATION CULTURE CONCEPT BETWEEN HORIZONTAL ORGANIZATIONS

IMPLEMENTATION PROCEDURE

1. RETROSPECT FOR THE PRECEDING YEA STATUS

2. FORECASING OR PREDICTING NEXT 3 5 YEARS ONCOMING TREND. CHANGE OR INNOVATION ON : TECHNOLOGY
   COMPETITORS
   ECONOMY
   CUSTOMER NEEDS
   IN NATIONAL AND
   INTERNATIONAL VIE

3. ANALYSIS. EVALUATE AND SUMMARIZE THE ABOVES FOR FUTURE DEVELOPMEN

4. ESTABLISHMENT FOR COMING YEAR OB- JECTIVES AND THEIR PROGRAM

5. DEPLOYMENT TO THE LOWER ECHELONS

6. ESTABLISHMENT FOR CONTROL & CHECI ITEMS

7. ESTABLISHMENT OR REFINEMENT SOPs

8. IMPLEMENTATION OF SOPs

9. EVALUATION IF OBJECTIVES ARE ACH- IEVED OR NOT. FOR FUTURE ACTIONS

1 Retrospection

1-1. THROUGH WEELY. MONTHLY AND ANNUA REPORTS. IDENTIFY PROBLEMS. WEAKNESSES OR POTENTIAL DIFFICULTY ENCOUNTERED ON THE PREVIOUS YEA BY THE LOWEST MANAGEMENT

ANALYZE CAUSES OR REASONS FOR SOLUTION/COUNTER-MEASURES WITH DATA AND FACT JUSTIFICATION AND SUBMIT TO HIS SUPERIOR

THIS REPORT IS CALLED AS "ANNUA STATUS REPORT"

1-2. FOLLOW AS SAME PROCEDURE AS PAR 1-1 BY EACH NEXT HIGHER SUPERIO AS HIGH AS GROUP OR DIVISION MANAGERS FOR PREPARATION OF ANNUA STATUS REPORT

ANNUAL STATUS REPORT WILL COVER:

WHAT OBJECTIVES ARE IN TROUBLE. SHOWN WEAKNESS. OR REVEALED POTENTIAL DIFFICULTY ? (SHOWN BY QUANTIFIED DATA AND FACT)

WHAT COUNTER-MEASURES ARE TAKEN ? (BY DATA ANALYSIS)

WHAT STATUS IS IT AFTER ACTION TAKEN ? (SHOWN BY DATA AND FACT)

HOW IS IT. GOOD OR BAD ?

WHY IS IT. OR WHY IS IT SO CRITICAL ? (SHOWN BY DATA AND FACT)

WHAT ARE RECOMMENDED FOR FUTURE ACTIONS ?

2 FORECASTING

2-1. PERTAINING TO OWN'S ORGANIZATIONAL FUNCTIONS, INVESTIGATE, ANALYZE, AND EVALUATE FOR:

FEASIBLE TECHNOLOGICAL ADVANCEMENT OR DEVELOPMENT

HOW STRONG COMPETITORS ARE HEADING FOR.

HOW CUSTOMER NEEDS ARE CHANGING

HOW ECONOMICAL SITUATION OR CONDITIONS ARE SHIFTING OR CHANGING.

IN NATIONAL OR INTERNATIONAL ENVIRONMENT.

2-2. IDENTIFY WHICH TECHNOLOGY OR CONCEPTION ARE MOSTLY PROBABLE TO BE INCORPORATED INTO PRODUCT OR SERVICE BY SCIENTIFIC ANALYSIS.

2-3. SUBMIT FOR SUCH IMPROVING NECESSITY INTO OWN'S FUNCTIONAL PLANNING FOR NEXT YEAR.

2-4. PROPOSE SUCH PLANNING WHILE EXPLAINING FOR BENEFIT, BREAK-EVEN POINTS, BUDGET AND OTHER NECESSARY REFERENCES FOR DECISION BY SUPERIORS.

3 EVALUATIONS

3-1. ANALYZE AND EVALUATE THE PROPOSALS SUBMITTED BY LOWER MANAGEMENT FOR ITS EFFECTIVENESS AND URGENCY WHILE SUMMARISING PREVIOUS YEAR'S STATUS AND TRENDS.

3-2. COLLECT MORE SPECIFIC INFORMATION REGARDING TO THE SUBJECTS TO BE EVALUATED. THROUGH OWN'S SPECIFIC NET-WORK SOURCES.

3-3. DISCUSS WITH SUPERIORS FOR FINAL DECISION TO BE FEASIBLE ENOUGH.

3-4. DECIDE FOR ACCEPTANCE AS ONE OF OBJECTIVE TO BE IMPLEMENTED IN THE NEXT YEAR BY TOP AND SUPERIOR MANAGEMENTS CONCURRANCES.

4 OBJECTIVE

4-1. THE TOP MANAGEMENT AND SENIOR EXECUTIVE MEETING ARE NECESSAR TO REVIEW THE REPORTS SUBMITTEI AS " ANNUAL STATUS REPORTS" FOR URGENCY OR SERIOUSNESS FOR CO'S FUTURE STRATEGY UNDER SURVIVAL AND DOMINANT COMPETITIVITY SUS-TENACES. BY EACH MIDDLE MANAGE-MENTS.

4-2. AT THE SAME TIME. THE PREVIOUS YEAR'S BUSINESS POLICY AND GOAI ARE NECESSARY TO RETROSPCT IF:

-- THE GOALS ARE ACHIEVED ?

-- THE ACTION ITEMS ARE PRO-CESSING AS PLANNED ?

THAT IS. IF ANY DIFFERENCES ARE VERIFIED BETWEEN THE RESULT ANI THE GOALS ESTABLISHED. AND CLAR-IFIED WHAT KINDS OF PROBLEMS ARE PRIME CAUSES FOR SUCH POOR DECISION AT THE PLANNING STAGE.

4-3. ALSO. THE TOP AND SENIOR MANAGE-MENT ARE NECESSARY TO SUMMARIZI EVERY AVAILABLE TECHNICAL AND BUSINESS RELATED HOT AND INNO-VATED INFORMATIONS RELATED WITI

OWN'S TECHNOLOGY. METHODOLOGY. COMPETITIVITY DOMINANCY AND SUPERIORITY SUSTENANCE AND BREAKTHROUGH NECESSITY.

4-4. AFTER EVALUATION OF THE ABOVES BY THE DIRECTORS MEETING. THE FINAL DECISION IS ISSUED BY THE TOP MANAGEMENT AS

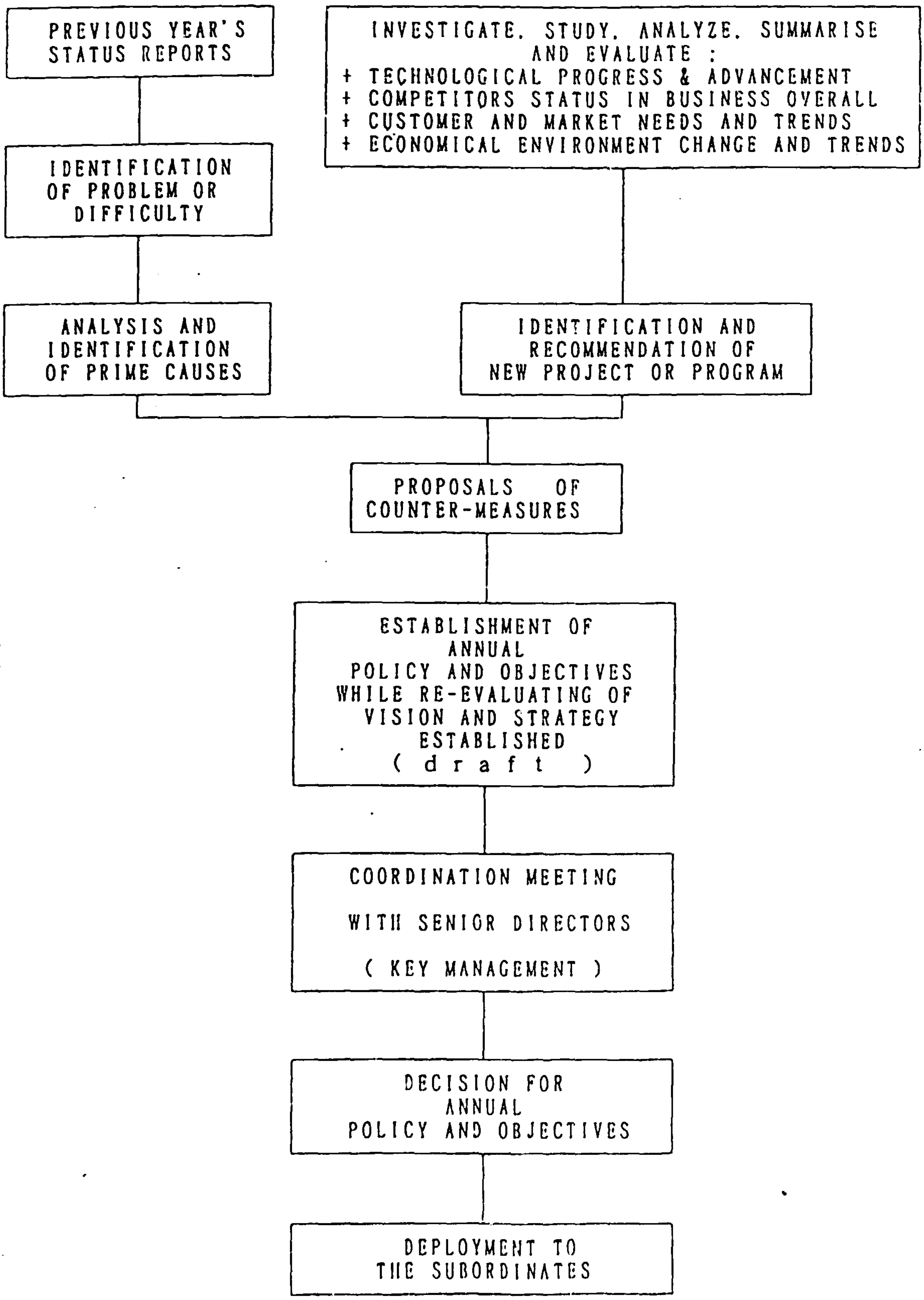
-- DETERMINATION OF OBJECTIVE

a) SELECT SPECIFIC AREA OR ELEMENT WHICH ARE NECESSARY TO IMPROVE/CORRECT/STRENGTHEN BY ARTICULATE EXPRESSION.

b) DETERMINE FOR MEASURING INDEXES FOR SUCH ELEMENTS

c) ESTABLISH DEFINITE GOALS TO BE ACCOMPLISHED FOR IMPROVING/CORRECTING/STRENGTHENING.

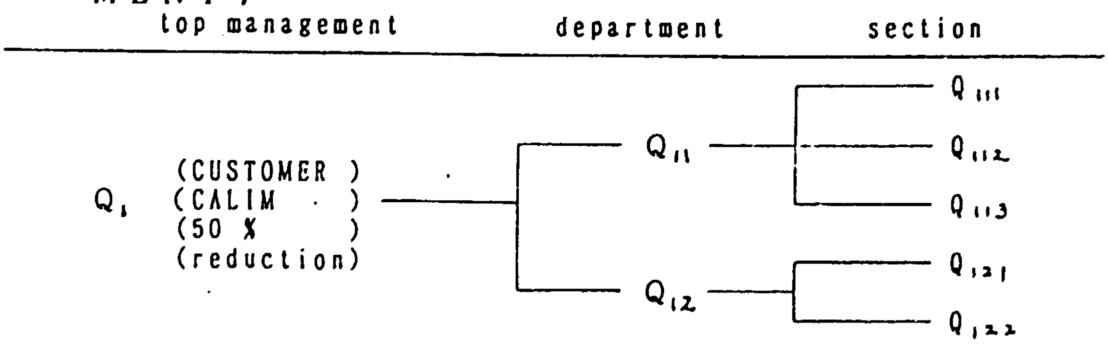
HOWEVER, IT USUALLY IS IDENTIFIED OR PROPOSED SO MANY KINDS OF TROUBLES/PROBLEMS/DIFFICULTIES THAT UNDER 'VITAL FEW' CONCEPT. THE MOST CRITICAL, URGENT, AND STILL EFFECTIVE AND EFFICIENT ACTIONALBLE ITEMS ARE NECESSARY TO SCREEN AMONG OF THEM FOR PRIORITIZING OF MANDATORY EXECUTION.


PREVIOUS YEAR'S STATUS REPORTS
INVESTIGATE, STUDY, ANALYZE, SUMMARISE AND EVALUATE :
+ TECHNOLOGICAL PROGRESS & ADVANCEMENT
+ COMPETITORS STATUS IN BUSINESS OVERALL
+ CUSTOMER AND MARKET NEEDS AND TRENDS
+ ECONOMICAL ENVIRONMENT CHANGE AND TRENDS
IDENTIFICATION OF PROBLEM OR DIFFICULTY
ANALYSIS AND IDENTIFICATION OF PRIME CAUSES
IDENTIFICATION AND RECOMMENDATION OF NEW PROJECT OR PROGRAM
PROPOSALS OF COUNTER-MEASURES
ESTABLISHMENT OF ANNUAL POLICY AND OBJECTIVES WHILE RE-EVALUATING OF VISION AND STRATEGY ESTABLISHED (draft)
COORDINATION MEETING WITH SENIOR DIRECTORS (KEY MANAGEMENT)
DECISION FOR ANNUAL POLICY AND OBJECTIVES
DEPLOYMENT TO THE SUBORDINATES

5. DEPLOYMENT

5-1. THE POLICY AND OBJECTIVE DELOYMENT HAS TWO KINDS.
ONE IS TO DEPLOY TO HIERARCHY MANAGEMENT WHO HAVE OWN'S SPECIFIC RESPONSIBILITY DELEGATED BY VERTICAL ALLOCATIONS.
THE OTHER IS TO DEPLOY TO NOT ONLY MANAGEMENT BUT SPECIALISTS WHO ARE NOT LEVEL OF MANAGEMENT TO FUNCTION FOR ACCOMPLISHMENT OF TOP MANAGEMENT REQUEST UNDER SPECIAL PROJECT, TASK OR ASSIGNMENT

5-2. THE DEPLOYMENT ARE, BASED ON THE 5W1H PROCEDURES, TO SPECIFY THE FRACTIONIZED UPPER MANAGEMENT POLICY AND OBJECTIVES TO NEXT LOWER MANAGEMENT DEPENDING ON THE LOWERS' ASSINGED RESPONSIBILITIES, AND CONTINUING ON UNTIL THE LOWEST LEVEL MANAGEMENT;



5-3. WHILE DEPLOYING ON. COORDINATION MEETING CALLED AS "CATCH-BALL" PROCESS ARE TAKING PLACE TO HAVE UNDERSTANDING SUPERIOR VISION. STRATEGY AND INTENTION BETWEEN THE TWO MANAGEMENTS. HOWEVER. SUCH DISCUSSION ARE ALWAYS CONDUCTING UNDER THE DATA AND FACT ORIENTED SYSTEMATIC & SCIENTIFIC APPROACH THAT PERSUATION. INSISTING OR COUNTERING ARE NECESSARY TO MENTION BY NO QUALITATIC BUT QUANTITATIVE.

5-4. SUCH DEPLOYMENT ARE NECESSARY TO SPECIFY A TIME-BASED SCHEDULE FOR ACCOMPLISHMENT AND CRICAL CONTROL-ITEMS WITH 5W1H REQUIREMENTS.

OBJECTIVE	WHY	WHAT	WHEN	WHERE	HOW	WHO
CUSTOMER CLAIM REDUCTION						

6 CONTROL ITEM

6-1. THE CONTROL ITEM IS DEFINED IN JIS AS.
" TO RATIONALLY CONDUCT QUALIT ASSURANCE ACTION IN EACH SHOPS. THE CONTROL ITEM IS DESIGNATED AS A SPECIFIC ITEM TO BE ASSURED IF IT IS UNDER CONTROLLED".

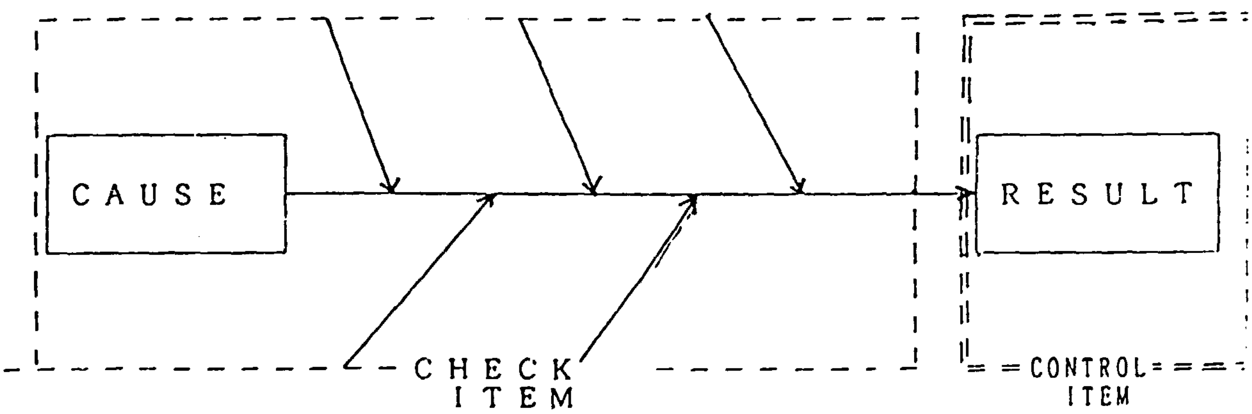
6-2. AS THE CONTROL ITEM. IT IS NECESSARY TO HAVE;

a) WHAT CHARACTERISTICS IS TO BE ASSURED
b) WHAT LEVEL OF CRITERIA I NECESSARY TO ACHIEVE THAT MUST BE SPECIFIED BY NUMERICAL VALU
c) HOW MUCH TOLERANCES ARE ALLOWABLE
d) HOW OFTEN IS IT NECESSAR TO BE ASSURED
e) WHAT ACTION(S) IS(ARE) NECESSARY WHEN FOUND OUT OF LIMITS
f) WHAT KINDS OF GRAPHICATION ARE NECESSARY
g) WHO HAS RESPONSIBILITY WHEN ABNORMALITY ARE OBSERVED

PRODUCTION SECTION MANAGER

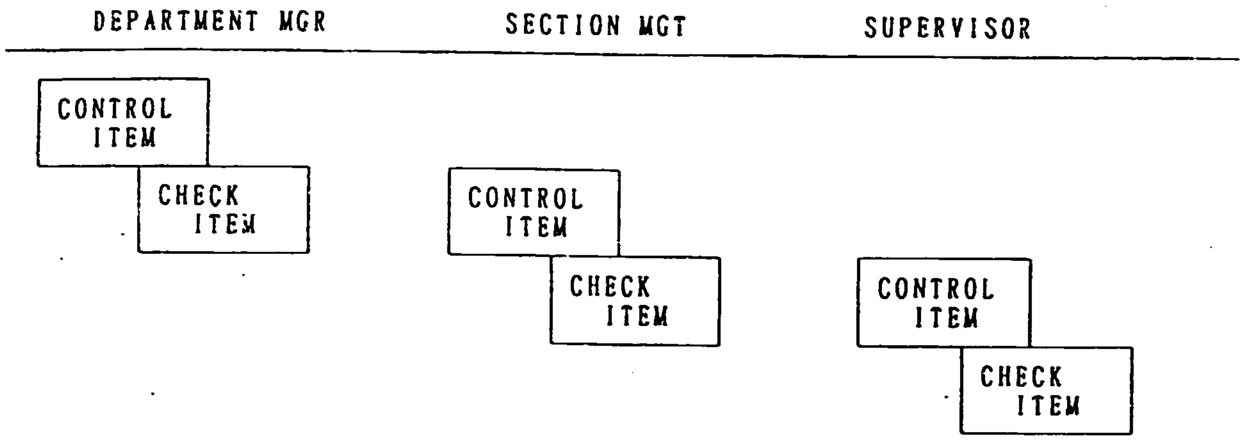
ASIC FUNCTION	WORK RESPONSIBILITY	CONTROL ITEM	CHECK AT	GOAL(CONTROL LEVEL)	ACTION FOR FAILURE	DATA
ASSURE PRODUCT SPECIFICATION (SOP) LIMITS	1. PROMOTE PROCESS-CONTROL	FAILURE RATE AT FINISHING PROCESS	MONTHLY	for IST SEM. XXX % (+0.3% -0.3%) for 2nd SEM YYY % (+0.3% -0.3%)	CAUSE ANALYSIS CORRECTIVE ACTION DIRECTION	FAILURE REPORT
	4. IMPROVE PROCESS CAPABILITY	Cp>1.33 ON MAIN PROCESS	MONTHLY	XXX %	CAUSE ANALYSIS CORRECTIVE ACTION DIRECTION	CONTROL GRAPH

6-3. THE CONTROL ITEM IS BASICALLY COVERED FOR RESULTANT ITEM SITUATED ON THE RESULT-SIDE AS SHOWN IN THE FOLLOWINGS;



AND LOCATED AT CAUSE-SIDE ARE CALLED AS 'CHECK ITEM' WHICH ARE USUALLY DELEGATED TO THE SUBORDINATES FOR THEIR CONTROL ALTHOHGH ACCOMPLISHING RESPONSI-

BILITIES ARE BELONGED TO THE MANAGEMENT. THIER RELATIONSHIP ARE.



ACCORDINGLY, SUPERIOR'S CHECK ITEMS ARE AUTOMATICALLY CALLED AS 'CONTROL ITEM' OF SUBORDINATE WHO HAVE A RESPONSIBLE FOR ACHIEVEMENT OF IT.

7. S 0 Ps RECHECK

7-1. AFTER DEFINING OF THESE CONTROL AND CHECK ITEMS, IT IS ABSOLUTELY NECESSARY TO REEVALUATE SOPS IF THESE SOPs ARE PHYSICALLY FEASIBLE ENOUGH TO ACHIEVE SUCH OBJECTIVES ESATABLISHED.

7-2. SOMETIMES, THESE OBJECTIVES SPECIFIED BY SUPERIOR ARE QUITE HIGHER LEVELED QUALITY THAT THE

EXISTED AVAILABLE SOP CANNOT COVER FOR SUCH CHALLENGING GOAL ACHIEVEMENT. THAT IS WHY EVERY SOPs ARE REQUESTED TO RE-REVIEW OR RE-EVALUATE FOR IDENTIFICATION OF REVISION NECESSITY BY RESPONSIBLE MANAGEMENT.

8 IMPLEMENTATION

8-1. PRIOR TO IMPLEMENT THE SOP REFINED, IT IS NECESSARY TO RE-EDUCATE THE SOP FOR REMINDING OF IMPORTANCE OF STANDARDS.

8-2. EVERY OPERATORS ARE INSTRUCTED NOT ONLY TO COMPLY WITH, BUT TO ASSURE THEMSELVES FOR STRICT CONFORMACE TO SOP, AND TO RECORD THE RESULTS OBTAINED.

9 EVALUATION

9-1. THE RESULTS OBTAINED ARE NOW NECESSARY TO COMPARE WITH THE STATEMENT SPECIFIED IN SOP IF MET WITH IT.

9-2. IF YES, PROCEED TO NEXT STEP. IF NOT, RETURN TO STEP 7 TO 8.

Approved	Date Prepared	
	Organization	
	Prepared By	

Policy & Objective Statement.

Why This Policy is Important	No.	Policy		Objectives		Necessary Action

PLANT	
SECTION	

PROBLEM ANALYSI'S & ACTION PROPOSED

PRE-PARED	DATE :		BY :

OBJECTIVES	CONTROL ITEM	GOAL	No	WHAT. HOW BAD.	WHY HAPPENED (CAUSE ANALYSI'S)
PROBLEM	STATUS				

	POTENTIAL OR ROOT CAUSE	No	CORRECTIVE ACTIONS PROPOSED	WHY	EXPECTING RESULT (HOW TO BE IMPROVED) 1ST RESULT	WHY	2ND RESULT	FOR NEXT SEMESTER

ORG.

SECTION

XX SEMESTER 19①②, PLANNING SHEET

PREPARED	DATE	BY	PRE-PARED	BY
APPROVED	DATE			

SUPERIORS GOAL	m	①	②	③	④	⑤
	CONTROL ITEM					
	GOAL					

n	①	②	③	④	⑤
PLANNING ITEM					
GOAL					
VALUE					

①	DATE	REMARK	WHY REVISED
REVISION			
APPROVED			
②	DATE	REMARK	WHY REVISED
REVISION			
APPROVED			

SUPERIORS VITAL FEW ITEMS	PLANNING VITAL FEW	CHECK ITEM	GOAL	WHEN CHECK	SCHEDULE 10	11	12	1	2	3	4	5	6	7	8	9

CONTROL PROCEDURE				ACTION		
CHECK TIME	FINISHING DATE	DATA NO.	REFERENCE NO.	IMPROVING VALUE	PROCEDURE	RESPONSIBLE PE[illegible]

CONTRIBUTION RATIO

◎ : LARGE CONTRIBUTION

○ : SOME CONTRIBUTION

△ : WITH RELATION

XXth WEEK IMPLEMENTATION STATUS

ORGANIZATION	
SECTION	

APPROVED	1ST SEM. BY		PREPARED BY		SIGNA
	2ND SEM. BY				

CONTROL ITEM		CONTROL CHARACTERISTICS GOAL / CHECK ITEM	1ST QTR 10	11	12	2ND QTR 1	2	3	3RD QTR 4	5	6	4TH QTR 7	8	9	REMARKS
	ACHIEVEMENT	CHARACTERISTICS													
		GOAL													
	STATUS FOR CRITICAL ITEM	CHECK ITEM (GOAL)													
		ACTIONS TAKEN													
		CHECK ITEM (GOAL)													
		ACTION TAKEN													

P

XX TH WEEK STATUS REPORT

ORGANIZATION	SECTION

POLICY	OBJECTIVES	STATUS REPORT		ACTION TO BE TAKEN FOR IMPORTANT PROBLEM
		ACHIEVED / NON ACHIEVED	PROBLEM / DIFFICULTY	

CRITICAL ITEM STATUS REPORT

XX TH WEEK

PREPARED	DATE
ORGANIZATION	
SECTION	
PREPARED	BY

CONTRIBUTION ⓐ
LARGE ● : 3
SOME ○ : 2
RELATED △ : 1

ⓑ IMPORTANCE

SUPERIORS GOAL

OUR GOAL

2 PT

1 PT

SUPERIOR'S CRITICAL ITEM

OUR CRITICAL ITEM

1st EVALUATION	2nd EVA e	f	g	h	A TOTAL	CRITICAL ITEM	CRITICAL ITEM	CHECK ITEM
ⓓ SUM UP								

2ND EVALUATION

CONTROL CHARACTERISTICS

GRAND TOTAL

GOAL

A = d + h

1ST SUM-UP d = Σ (a × b)

PREPARED : AT
ORGANIZATION
PREPARED : BY

XXTH WEEK. PROBLEM REPORT. (MONTHLY)

CONTROL ITEM	(GOAL)	( ) MONTH GOAL (VALUE)	( ) MONTH GOAL (TOLERANCE)	( ) MONTH FACT OBTAINED

HOW BAD	

CRITICAL ITEM	CRITICAL ITEM	ACTION ITEM.

CAUSE ANALYSIS	

POTENTIAL OR ROOT CAUSE(S)	CORRECTIVE ACTION PROPOSED	SCHEDULE MONTH 1	2	3	4	REMARKS

Company MBP in 1991

1. ENSURE STABLE SUPPLY AND RESPOND CUSTOMER DEMAND

2. REDUCE COST AND IMPROVE OPE-RATIPNAL EFFICIENCY IN ORDER TO KEEP ELECTRICITY COST STABLE

3. PLAN AND PROMOTE RECYCLING ACT-IVITY

4. IMPROVE RELIABILITY AND DEVELOPE CLOSER RELATIONSHIP WITH CUSTOME BY PROVIDING BETTER SERVICE AND CONTRIBUTING TO THE COMMUNITY

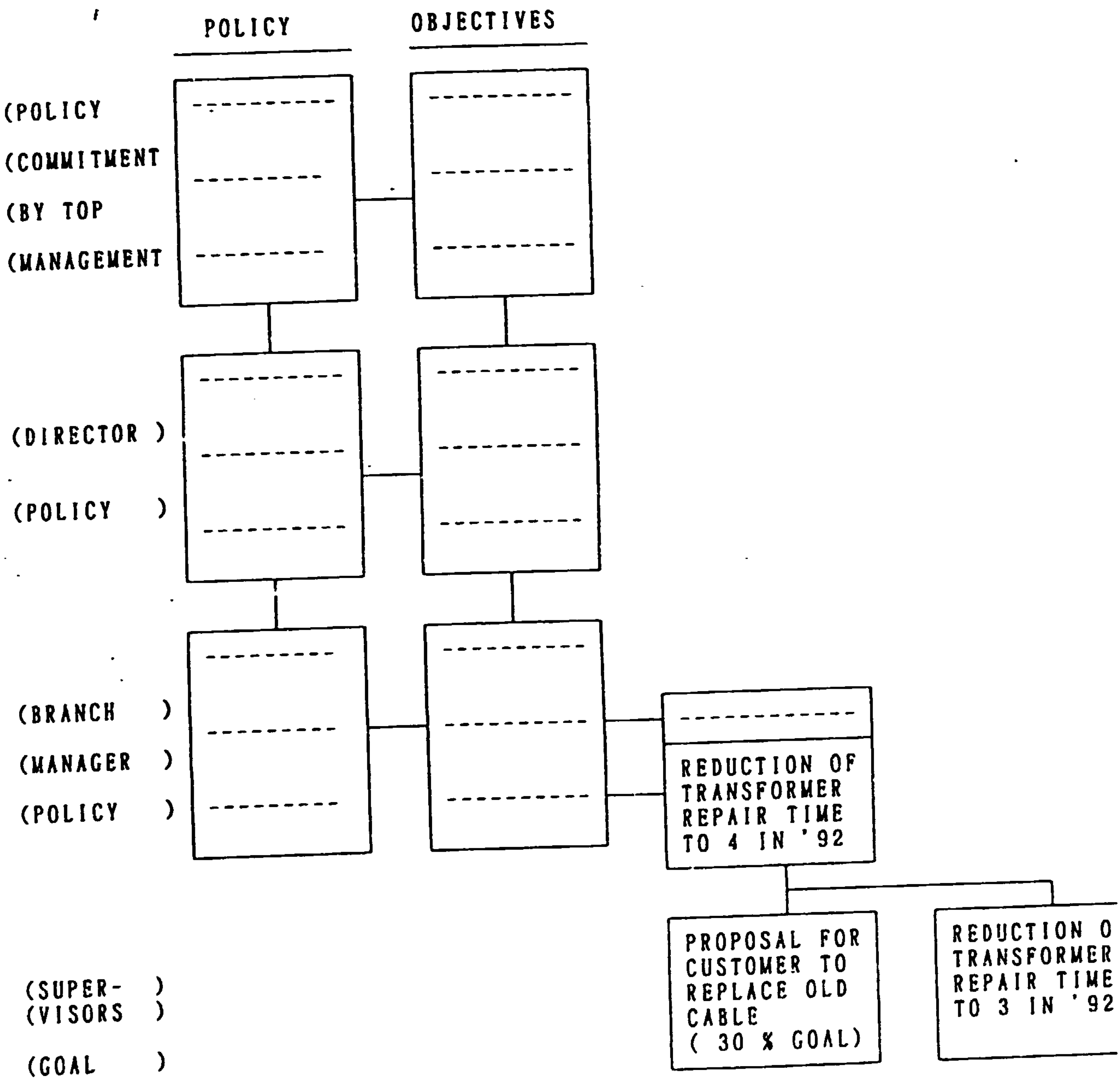
5. CREATE A MORE COMFORTABLE WORK-ENVIRONMENT

policy	objective	measurement
----------- -----------	---------------------- ----------------------	---------------------------------- ----------------------------------
improvement of customer service	power failure time reduction per independent house	7 minutes/ house

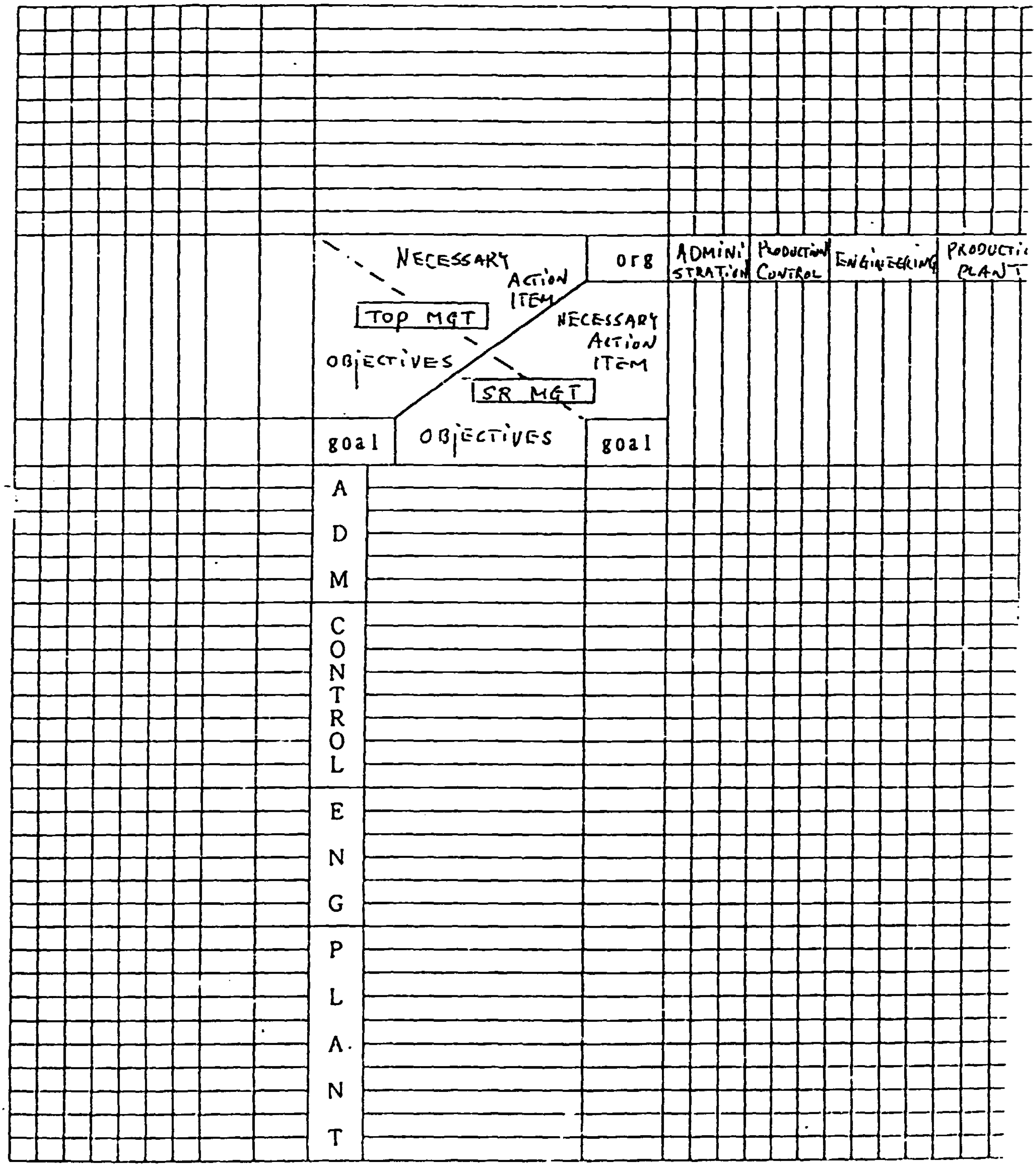
REDUCTION OF INTERRUPTION TIME BY SERVICE

	POLICY AND OBJECTIVE	MEASUREMENT
(POLICY COMMITTED (BY TOP MANAGE- (MENT	PROVIDE SERVICE FOR CUSTOMER SATISFACTION	7 MINUTES/ CUSTOMER/YR
(DIRECTOR (POLICY	REDUCTION OF INTERRUPTION TIME BY SERVICE	5 MINUTES/ CUSTOMER/YR
(BRANCH MANAGER (POLICY	REDUCTION OF INTERRUPTION TIME CAUSED BY ACCIDENTS	4 FAILURES/ SUBSTATION/ YI
		30 % REPLACE- MENT OF OLD CABLE IN CUSTOMER

REDUCTION OF INTERRUPTION TIME BY SERVICE



relationship matrix between top and senior management



OBJECTIVES	GOAL
1. DELIVERY CLAIM	≦8/5 mont
2. CLAIM FOR NEW CAR	50 % DOW
3. COST REDUCTION (OVER-ALL)	3890 MY
4. PRODUCTIVITY IMPROVE'T	7.1 %
5. VEHICLE SALES WITHIN NISSAN GROUP	4.12 B¥
6. VEHICLE SALES OUTSIDE NISSAN GROUP	8600 M¥
7. OTHER COMMODITY SALES	600 M¥
8. NEW PRODUCT SALES	50 M¥
9. ADVANCED SALES IN NEXT-SEMESTER PER MODEL	> 10 %
10. GROSS PROFIT RATIO PER NEW VEHICLE PROJECT	14.5 %
11. NEW TECHNOLOGY DEVELOPMENT TERMS	± 0 D
12. ASSET INVENTORY ROTATION RATIO	35 / Y
13. PROFIT INCREASING AT PLANT IN FOREIGN COUNRIES	> 0.5 M
14. PROFIT INCREASING AT SUBSIDIARY COMPANIES	> 10 M
15. IMPLEMENTATION OF HUMAN-RESOURCE MANAGEMENT SYSTEM BASED ON " CAPABILITY FIRST " PRINCIPLE	WILL START ON C

1. PREVENTION OF BAD-PRODUCT SHIPPING TO THE NEXT-DOWN SRTEAM SHOP BY AUTONOMOUS QUALITY ASSURANCE CONCEPT.

2. FEED-BACK MARKET-INFORMATION AND CLAIM-CAUSE ANALYSIS REPORTS INTO SOP OF QUALTIY GOAL ACHIEVEMENT.

3. COST-REDUCTION BY COST-ELEMENT. AND OVERALL COST AT EACH ORGANIZAT BY EACH RESPONSIBLE PERSONNEL.

4. PERSONNEL AND MAN-HOUR CONSERVATION THROUGH NEW EQUIPMENT INVESTME TECHNIQUE AND PROCESS IMPROVEMENT AND WORK-SHOP IMPROVEMENT.

5. INCREASE OF PURCHASING ORDERS ON PARTS ALREADY ORDERED

6. NEW MARKET DEVELOPMENT ON NEW COMPANY SUCH AS F- AND I-COMPANY.

7. NEW MARKET SHARE EXPANSION BY NEW PRODUCTS.

8. IMPLEMENTATION FOR NEW-MERCHANDISING DECISION SCHEME.

9. DEVELOPMENT OF NEW STRATEGIC MODEL IN NEXT SEMESTER.

10. DEVELOPMENT OF STRONG COST-DECISION SYSTEM AT THE VERY BEGINNING S SUCH AS CONCEPT PHASE THROUGH DESIGN VA AND PROCESS INNOVATION MET

11. ACCOMPLISHMENT OF "NEW MODEL DEVELOPMENT" SCHEDULE AS PLANNED.

12. SHORTENING OF LEAD-TIME BY INNOVATED PRODUCTION SYSTEM.

13. ENFORCEMENT OF MANAGEMENT LEADERSHIP.

14. ENSTRENGTHENING OF SUBSIDIARY COMPANYS' MANAGEMENT SUPPORTS

15. IMPROVEMENT OF 'PERSONNEL MERIT EVALUATION' SYSTEM. AND IMPLEMETAT OF JOB-ROTATION PROGRAM.

A D M I S T R A T I O N	1. REDUCTION OF CUSTOMER CLAIM BY SUPPLIED PARTS	7 / 2 MONT
	2. PARTICIPATION RATIO FOR MARKET CLAIM REDUCTION PROGRAM ON NEW-CAR BY SUPPLIED PARTS	5 %
	3. BUDGET REDUCTION FOR OVER ADMINISTRATION OFFICE	2.401
	4. EFFECTIVE UTILIZATION OF REDUNDANT PERSONNEL	160 MEN
	5. INCREASE SALES TURN-OVER RATE IN NISSAN GROUP	500 M¥
	6. INCREASE SALES TURN-OVER RATE OUTSIDE NISSAN GP	460 M¥
	7. INCREASE SPARE PARTS	150 M¥
	8. INCREASE OTHER COMMODIDTY SALES	600 M¥
	9. INCREASE NEW PRODUCTS SALES	500 M¥
	10. INCREASE SALES BY MODELS	> 10 %
	11. FULL ACHIEVEMENT OF THE STATEMENT OF PROFIT AND LOSS BY MONTHLY BASIS	100 %
	12. FULL ACHIEVEMENT OF THE STATEMENT OF PROFIT AND LOSS AT SUBSIDIARY PLANTS	100 %
	13. ESTABLISHMENT OF PERSONNEL MERIT EVALUATION SYSTEM	BY THE E OF OCT.

PRODUCTION CONTROL	1. REDUCTION OF CLAIM BY SPARE-PARTS DELIVERED TO CUSTOMERS	0 / MONT
	2. INCREASE FOR IMPROVING SUGGESTION PROPOSAL	4 / MONT
	3. VALIDATION FOR QUALITY ASSURANCE AND PROPOSAL NUMBERS	3 / VEHI
	4. REDUCTION OF OVERALL BUDGET	1.75 M¥
	5. IMPROVEMENT FOR PRODUCTIVITY IMPROVEMENT (HR)	1.2 %
	10. PARTICIPATION RATIO COST REDUCTION	50 %
	12. FINISHED PRODUCTS STOCKING DAYS IN WAREHOUSE	3.3 DAYS 661.0 M¥
	13. DISPATCH PERSONNEL FOR IMPROVEMENT PROJECT	4 MEN,
	14. PARTICIPATION FOR IMPROVEMENT PROJECT	6 / YEA

ENGINEERING	1. PARTICIPATION RATIO FOR 50 % CLAIM REDUCTION PROJECT ON NEWLY DELIVERED CAR BY CUSTOMERS	65 %
	2. EXPENSE REDUCTION OF OVERALL TECHNICAL ORGANIZATION BUDGET	180 M¥
	4. PRODUCTIVITY IMPROVEMENT CONTRIBUTION RATION BY SPECIFICATION CHANGES	1.2 %
	7. ADHERENCE TO THE SCHEDULE OF NEWLY ORDERED PRODUCT	± 0 D
	8. DEVELOPMENT OF NEW MERCHANDISES	12 EA
	9. MERCHANDISING RATION BY PROJECTS	100 %
	10. PARTICIPATION RATIO FOR COST-REDUCTION BY SPECIFICATION CHANGE	50 %
	11. PROGRESS STATUS FOR TECHNOLOGY DEVELOPMENT	± 0 D
	13. DISPATCH ENGINEER FOR SUPPORT FOR IMPROVEMENT PROGRAM	4 MI
	14. MATERIAL CHANGES FOR PROCESS IMPROVEMENT	20 CAS

P R O D U C T I O N	1. REDUCTION OF CUSTOMER CLAIMS CAUSED BY IN-HOUSE PRODUCTS	2 1 / 3 MO
	2. REDUCTION OF RECURRENT CLAIM BY CUSTOMER	5 0 %
	3. PARTICIPATION RATIO AT 50 % CLAIM REDUCTION PROGRAM FOR NEW MODEL DEBUT IN MARKET	3 0 %
	4. COST REDUCTION FOR OVERALL PRODUCTION OPERATION --- REDUCTION OF DIRECT MAN-HOUR COST --- CONSERVATION OF ENERGY COST --- REDUCTION OF PROCESS FAILURE --- MOLDING JIG FABRICATION IN HOUSE	 2 9 2 M¥ 7 0 M¥ 5 5 M¥ 7 7 M¥
	5. PARTICIPATION OF PRODUCTIVITY IMPROVEMENT 12. REDUCTION OF IN-PROCESSING PARTS IN WAREHOUSE	4 . 7 % 2 . 7 DAY 5 5 1 . 0 M¥
	13. RAW MATERIAL, AUXILIARY MATERIAL IN WAREHOUSE	1 . 2 DAY 2 3 9 . 0 M¥
	14. DISPATCH EMPLOYEES TO SUPPORT FOR IMPROVEMENT OF INPROCESS	6 MEN/Y
	Z-1. SECURITY AT WORK-SHOP	0 ACCID
	Z-2. QUALIFIED EMPLOYEES MET WITH GOVERNMENT CERTIFICATION PROGRAM	2 0 MEN HIGHER THAN 3RD SKILLS IN MORE THAN 3 KINDS OF SKILL CLASSIFICATION

ADMINISTRATION	1. SUVSTANTIALITY IMPROVEMENT FOR AUTONOMOUS QUALITY ASSURANCE PROCE-DURES AT THE WORST 5 COMPANIES
	2. REDUCTION OF CLAIM FOR NEW DELIVERED VEHICLE BY PREVENTIVE ACTIONS FOR INPROCESS FAILURE AT PRE-PRODUCTION STAGE
	3. REDUCTION OF COST OF RAW MATERIAL AND SUPPLIED COMPONENTS BY WAY C VALUE ANALYSIS METHODS
	4. IMPROVEMENT OF PROFITS OTHER THAN SALES BY CAPITAL INVESTMENT
	5. REDUCTION OF WORKING MAN-HOUR BY JOB EFFICIENCY IMPROVEMENT
	6. EFFECTIVE UTILIZATION OF MAN-POWER WHICH ARE ENFORCED ON CRITICAL. OR IMPORTANT WORK-AREA
	7. TACKLE PURCHASING ORDER WHICH ARE PLACED ON OTHER COMPANY IN NISSA GROUP
	8. OPEN A NEW OFFICE-WINDOW FOR DEALING WITH NEW A-COMPANY BUSINESS. AND ENFORCEMENT FOR NEW-COMPONENT PURCHASE-ORDER ACQUIRING
	9. DEVELOP A NEW PRODUCT TO MEET WITH F-COMPANY REQUEST/NEED
	10. CULTIVATE NEW MARKET BY WAY OF HUMAN-RELATIONSHIP
	11. IMPROVEMENT SYSTEMS FOR AN ACCEPTANCE OF PURCHASE ORDERS AND SHIP-MENT AND ENFORCEMENT OF ABC CONTROL SYSTEM
	12. MARKET ENLARGEMENT BY DISPLAYING OF NEW PRODUCTS AT EXHIBITION, TRADE-FAIR, TECHNICAL MEETING, OR INFORMATION EXCHANGING CONFERENC
	13. MARKET ENLARGEMENT FOR SPARE PARTS AT STATE-FAIR OR EXHIBITION
	14. SUPPORT ENFORCEMENT THROUGH CLARIFICATION OF OBJECTIVES AND IDENTI-FICATION OF CONTROL ITEMS
	15. ENFORCEMENT OF SUPPLIERS BUSINESS MANAGEMENT CAPABILITY BY SUPPORT OF MONETARIAL INVESTMENT OR MAN-POWER DISPATCHEMENT
	16. STANDARDIZATION OF EMPLOYEES MERIT EVALUATION SYSTEM AMD IMPLEMEN-TATION OF JOB-ROTATION SYSTEM BY WAY OF TALENTED PERSONNEL DISTRI-BUTION MAP

PRODUCTION CONTROL	1.	ANLYSIS AND COUNTER-MEASURES FOR CAUSES ON CUSTOMER CLAIMS (FAILUR
	2.	RECOMMENDATION FOR QUALITY ASSURANCE PROCEDURES WHICH ARE REVEALED BY QUALITY SYSTEM ASSESSING SURVEY
	3.	ESTABLISHMENT OF STANDARD OPERATION PROCEDURES (S O P) AND GUARANTEE FOR QUALITY
	4.	IMPROVEMENT AND RATIONALIZATION OF WORK EFFICIENCY AND CLERICAL JO ADDED VALUE
	5.	PRODUCTIVITY DEVELOPMENT BY INDUSTRIAL ENGINEERING TECHNIQUE IMPRO MENT
	6.	COST REDUCTION BY INDUSTRIAL ENGINEERING TECHNIQUE IMPROVEMENT
	7.	SHORTENING OF LEAD-TIME BY IMPLEMENTATION OF NEW PRODUCTION SYSTEM
	8.	PRODUCTIVITY IMPORVEMENT BY INDUSTRIAL ENGINEERING SUPPORTS
	9.	PRODUCTIVITY IMPROVEMENT BY INDUSTIRAL ENGINEERING GUIDANCE

ENGINEERING	1.	IMPLEMENTATION OF COUNTER-MEASURES FOR MARKET CLAIM, WHICH IS CORRECTED FOR PRODUCT SPECIFICATION
	2.	FULL ACHIEVEMENT OF COMPULSARY OBJECTIVES SPECIFIED FOR RATIONALIZATION OF TECHNICAL DEVELOPMENT ORGANIZATION BY COST ELEMENTS
	3.	IMPROVEMENT OF PRODUCTIVITY LEVEL BY SPECIFICATION CHANGES
	4.	EXPEDITION OF SPECIFIC MERCHANDIZATION FABRICATION FROM A GENERAL COMPONENT BASED ON CRITICAL PARTS AND SPECIAL PARTS DEVELOPMENT PLANNING SCHEDULES
	5.	FULL ACHIEVEMENT OF NEW PRODUCT DEVELOPMENT PROGRAM IN 1992
	6.	DECISION FOR SALES-POINTS ON NEW MODEL VEHICLE AND EXPEDITION OF DEVELOPMENT
	7.	DEFINITE DECISION FOR NEW SPECIFICATION OF NEW MODEL VEHICLE BASED ON FIXED-COST
	8.	PROMOTION FOR NEW MERCHANDISE DEVELOPMENT UNDER MEDIUM TERM PROJEC
	9.	PROMOTION FOR FUNDAMANTAL SPECIFIC TECHNOLOGICAL DEVELOPMENT ITEM
	10.	DISPATCH ENGINEERS FOR TECHNICAL SUPPORT FURNISHMENT AT PLANTS IN FOREIGN COUNTRIES
	11.	DISPATCH ENGINEERS FOR TECHNICAL SUPPORTS AT N- AND S-COMPANIES TO IMPROVE THEIR PROFITABILITY

PRODUCTION	1. ESTABLISHMENT AND EXPANSION OF PRODUCTION LINE WHICH ARE PHYSICALLY VISIBLE AND VERIFIABLE FOR THEIR QUALITY-ASSURING SYSTEM UNDER SELF CONTROLLING CONCEPT
	2. IMPROVEMENT FOR RECURRENT PROBLEM PREVENTION PROCESSES AND PROCEDUR THROUGH EMPLOYEES AWARENESS RECOGNITION AND FOOL-PROOF EQUIPMENT INSTALLATION
	3. THOROUGH ANALYSIS AND CORRECTIVE ACTION ESTABLISHMENT FOR THE WORST FAILURE HAPPENING PROCESSES AND WORK-SHOPS
	4. CONTINUOUS IDENTIFICATION AND FULL CORRECTIVE ACTIONS ESTABLISHMENT FOR IMPROVEMENT NECESSITY ITEMS BASED ON RATIONALIZATION REQUIREMENT SUCH AS:
	--- ABOLITION FOR MANUAL-FINISHING PROCESS
	--- STREAM-LINED PRODUCTION PROCESSES BY ALL-INHOUSE OPERATION WHICH ARE ENABLE TO DO THROUGH NEW MACHINERY INSTALLATION
	--- INSTALLATION AND EXPANSION OF AUTOMATIC OPERATION AND HIGH SPEED MACHINING EQUIPMENT
	--- EFFECTIVE UTILIZATION OF OPERATOR BY IN-CHARGING OF MULTI PLE MACHINE HANDLING CONCEPT
	--- ENERGY CONSERVING OPERATION PROGRAM IMPLEMENTATION PLANNED BY THEORETICAL ENERGY CONSUMING ANALYSIS
	--- FULL IMPLEMENTATION OF ON-CONDITIONING MAINTENANCE CONCEPT AND IMPROVEMENT OF EQUIPMENT AND TOOL AND JIG
	--- PREPARATION OF MANUAL(KNOW-HOW BOOK) FOR MOLDING MEATAL DIE MANUFACTURING TECHNIQUE AND REDUCTION OF MOLDING FAILURE BY USING OF IT
	5. CONTINUOUS IMPROVEMENT BY PREPLANNED PROGRAM
	--- ESTABLISHMENT AND EXPANSION OF HIGH-EFFICIENCY PRODUCTION LINE
	6. DISSEMINATION AND FULL IMPLEMENTATION OF NEW PRODUCTION LINE SYSTEM AND REDESIGN AND REORGANIZATION OF PRODUCTION ALLOCATION SUCH AS INHOUSE OR SUPPLIER PRODUCTION
	7. DISPATCH EMPLOYEES TO OTHER FACILITIES FOR SUPPORT OF PROCESS IM PROVEMENT
	8. INSTALLATION AND IMPROVEMENT FOR FINGER OR HAND INJURY PREVENTING EQUIPMENTS
	9. HAVING PARTICIPATION FOR TECHNIQUE AND SKILL REFRESHING COURSES

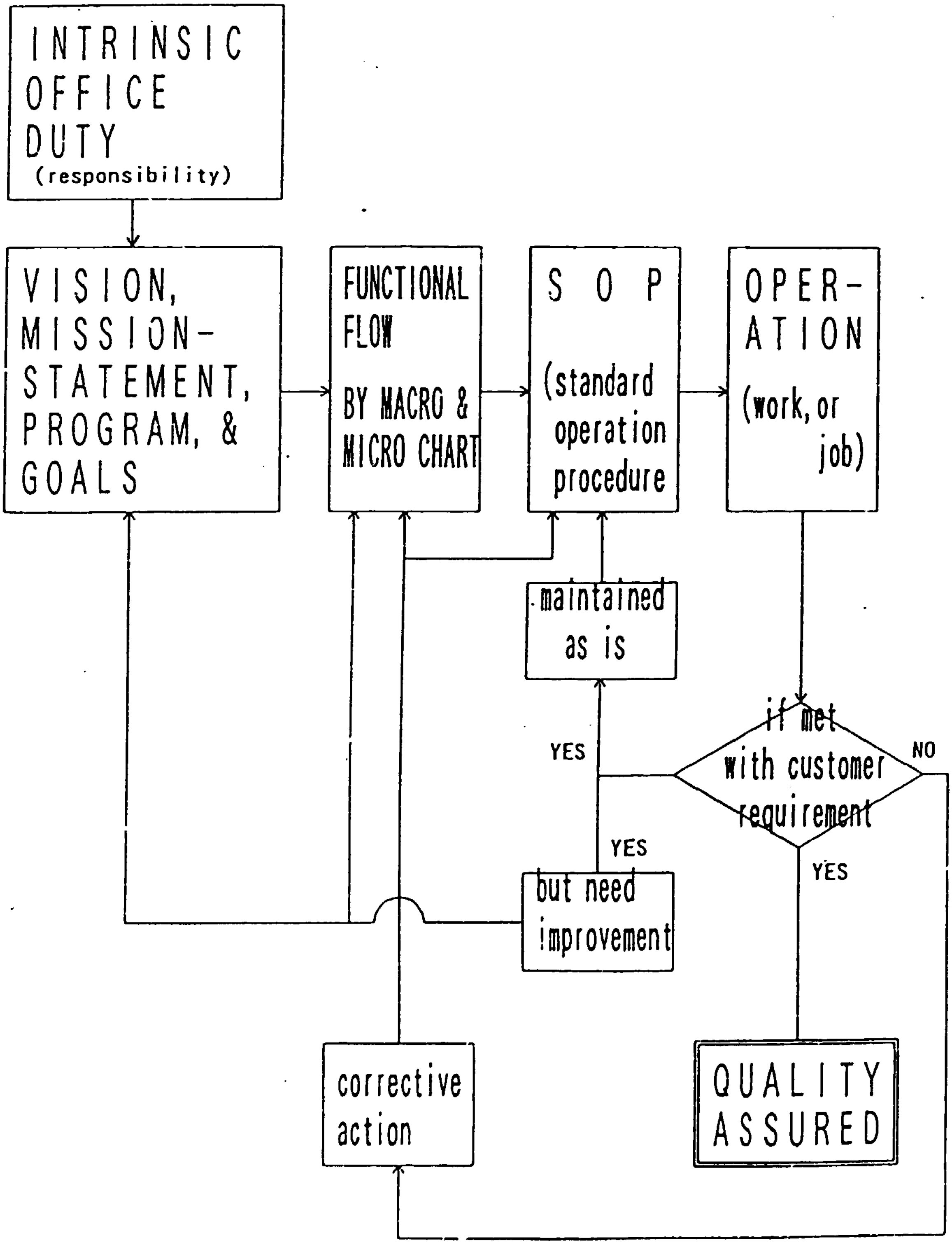
DAILY ROUTINE-WORK MANAGEMENT

IT IS DEFINED, BY DR. N. KANO, AS " EVERY NECESSARY ACTIONS TO BE PERFORMED FOR ACCOMPLISHMENMT OF THEIR SPECIFIC DAILY ROUTINE-WORKS ASSIGNED TO EACH SEGMENTAL OAGANIZATIONS, WHICH ORGANIZATIONS ARE BASICALLY CONSIDERED AS SECTION OR UNIT LEVEL STRUCTURED."

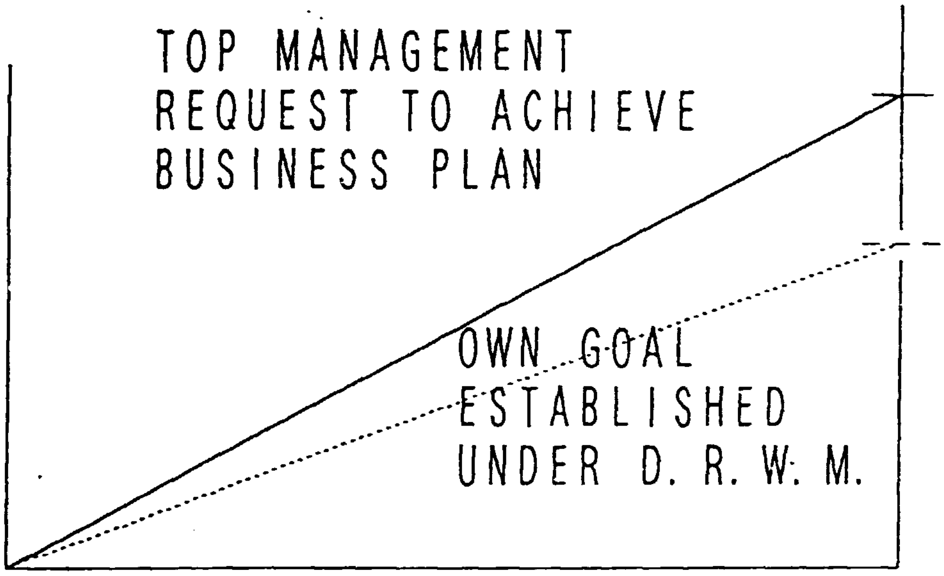
TO EFFECTIVELY FUNCTION FOR THEIR OWN ASSIGNED RESPONSIBILITY, IT IS NECESARY FOR EACH MIDDLE-MANAGEMENT TO ESTABLISH THEIR OWN VISION, GOALS, AND THEIR PROGRAM FOR ACHIEVEMENT, AND TO STRIVE FOR MAINTAINING AND IMPROVING TILL ATTAINING TO SUCH LEVEL OF DAILY ROUTINE-WORK QUALITY MUCH HIGHER THAN BENCH-MARK STUDIED THROUGH CONTINUOUS TIRELESS EVER-ONGOING CONCEPT.

FLOW-CHART

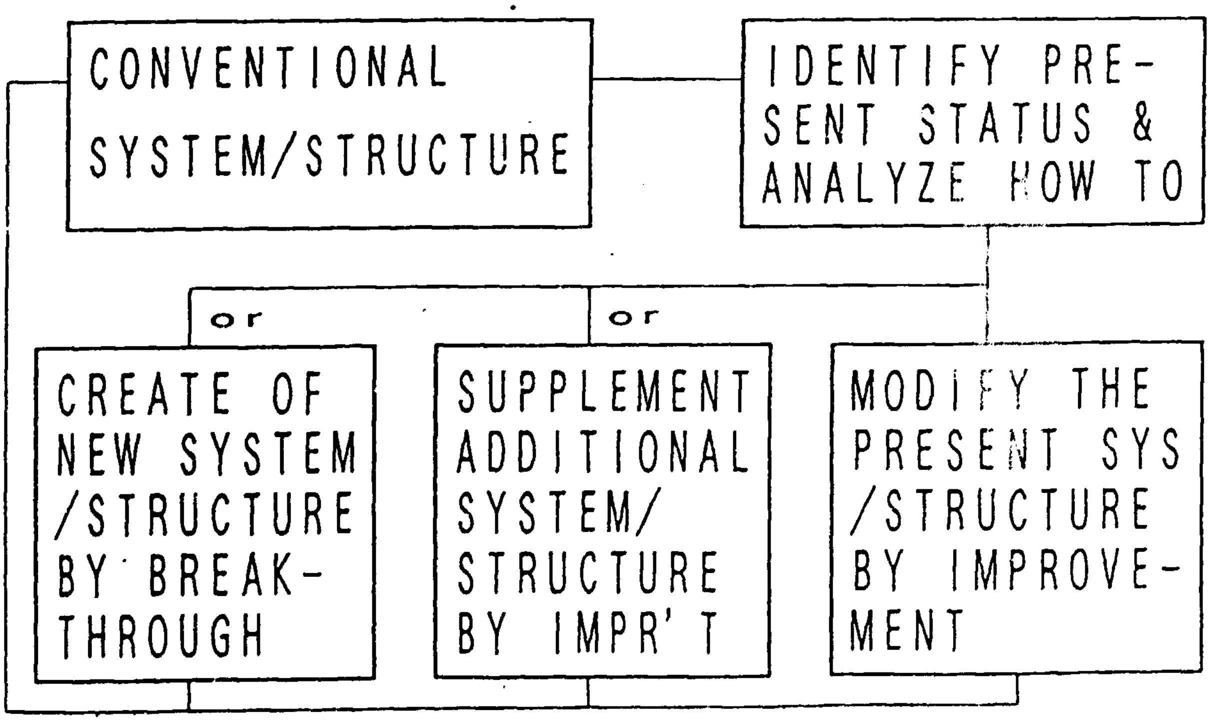
(DAILY ROUTINE-WORK MANAGEMENT)



CHALLENGABLE OBJECTIVE ESTABLISHMENT

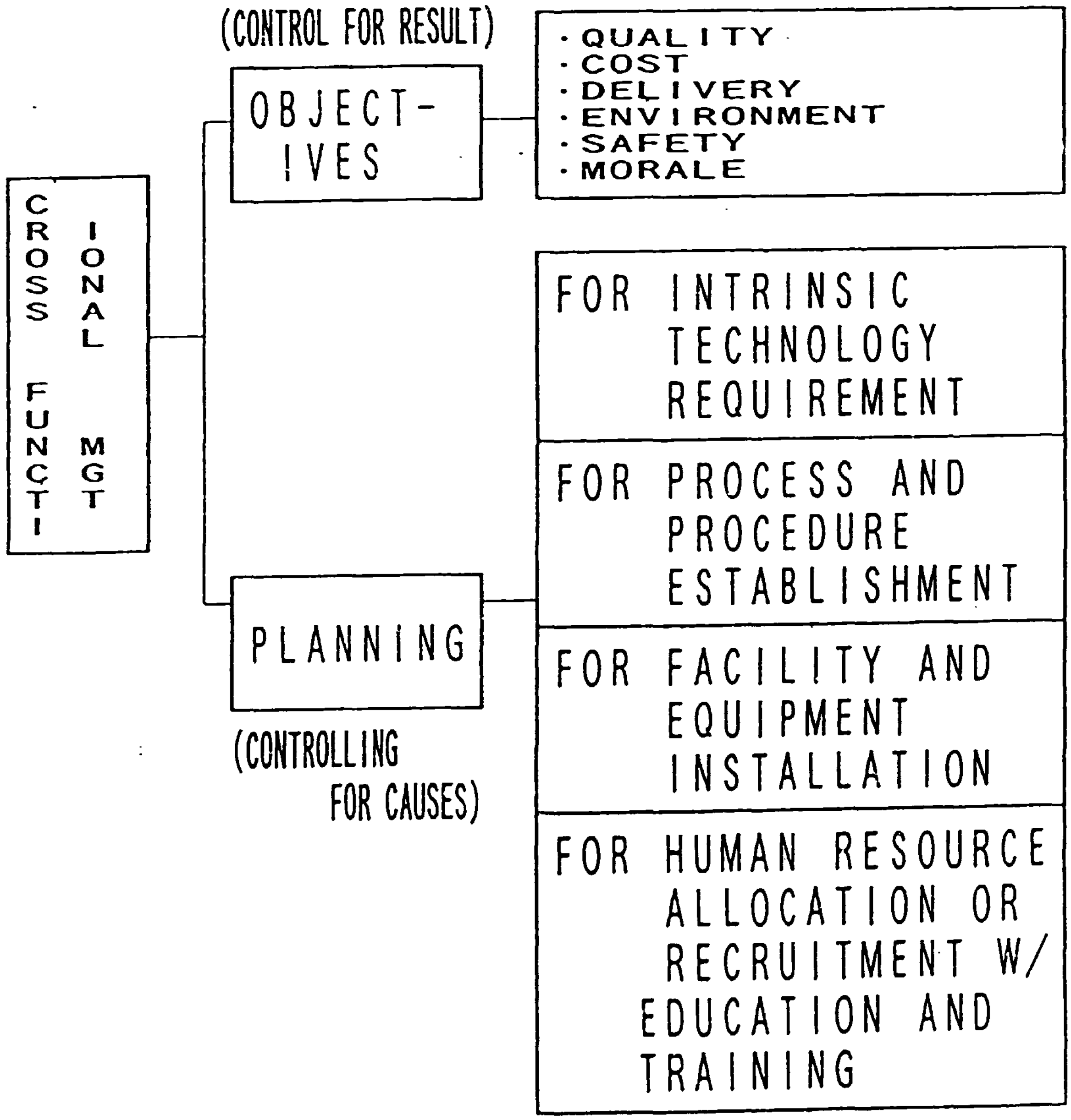


TO ACCOMPLISH SUCH CHALLENGED GOAL REQUESTED BY TOP MANAGEMENT, IT IS NECESSARY TO ESTABLISH THE FOLLOWING PROGRAM FOR ACCOMPLISHMENT;



CROSS-FUNCTIONAL MANAGEMENT

(OBJECTIVE AND PLAN ESTABLISHMENT)



DAILY ROUTINE– WORK MANAGEMENT IMPLEMENTATION FLOW

PLAN

1. RECONFIRM OWN 'S JOB DESCRIPTIONS AND OFFICE DUTIES ASSIGNED WHILE REFERRING CO' S REGULATION, AND IDENTIFY THE INPUTS (WHAT, WHEN, WHO WHERE, OR WHICH ?) TO BE DELIVERED AND OUTPUTS (WHAT, WHEN, WHO, WHERE, OR WHICH ?) TO DELIVER.
2. BASED ON THE OFFICE DUTIES SPECI- FIED, ESTABLISH OWN 'S VISION AND STRATEGY TO BE ACCOMPLISHED WITH- IN ASSIGNING DURATION.
3. IDENTIFY OWN' S INTERNAL & EXTER- NAL CUSTOMERS, AND SHAKE-DOWN FOR REVEALING OWN' S WEAKNESS AND/OR STRENGTH ON CUSTOMERS' QUALITY FOR OWN' S FUNCTION AND PERFORMANCES.
4. ESTABLISH OWN' S LONG/MEDIUM TERM OBJECTIVES & PLANS FOR CORRECTION OF WEAKNESS OR RETENTION OF ST- RENGTH AND DETERMINE THE ANNUAL ONES, WITH SUBORDINATES CONSENSUS.

5. ESTABLISH STANDARD OPERATION PROCEDURES(S O P) FOR FULL ACCOMPLISHMENT OF OWN'S DUTIES ASSIGNED BY WAY OF MACRO/MICRO FLOW CHART.

6. ESTABLISH CONTROL/CHECK ITEMS FOR MEASURABLE INDEXES, AND ALSO CONTROLLING LEVELS BY WAY OF WORK/JOB ANALYSIS DEPLOYMENT PROCEDURES.

7. TRAIN AND FAMILIARIZE EVERY SOPs TO EVERY SUBORDINATES IN ORGANIZATIONS.

8. PREPARE NECESSARY MATERIAL, TOOLS, MACHINES, OR EQUIPMENT FOR AVAILABILITY.

DO

9. IMPLEMENT S O P AS SPECIFIED.

CHECK

10. MEASURE RESULTS OBTAINED AND PLOT THEM ON CONTROL CHART/GRAPH BY CONTOL/CHECK ITEMS.

11. IF FOUND WITHIN CONTROL-LIMITS, CONTINUE ON FOR OPERATION AS 9 STEP.

ACT

12. IF NOT, RETURN TO STEP 3 -- 9 FOR CORRECTIVE ACTION(S)
13. ESPECIALLY, EVALUATE CRITICAL CONTROL ITEMS BY DESIGNATED INTERVAL FOR ACHIEVEMENTS,
    EVEN IF IT IS WITHIN LIMITS, BUT ITS TREND BE ASSUMABLE OR PRREDICTABLE FOR OUT-OF-LIMIT NEAR FUTURE, IT MIGHT BE ACCEPTED AS AN WARNING FOR PRECAUTIONAL ACTION NECESSITY.

CONTROL ITEM

CONTROL ITEM IS DEFINED AS;

" IT IS ESTABLISHED FOR EVERY ORGANIZATION TO VERIFY AND EVALUATE IF THE THEIR ASSIGNED WORKS ARE FULLY ACCOMPLISHED AS SPECIFIED AND IF NOT CONFORMED, TO TAKE ANY NECESSARY CORRECTIVE ACTIONS."

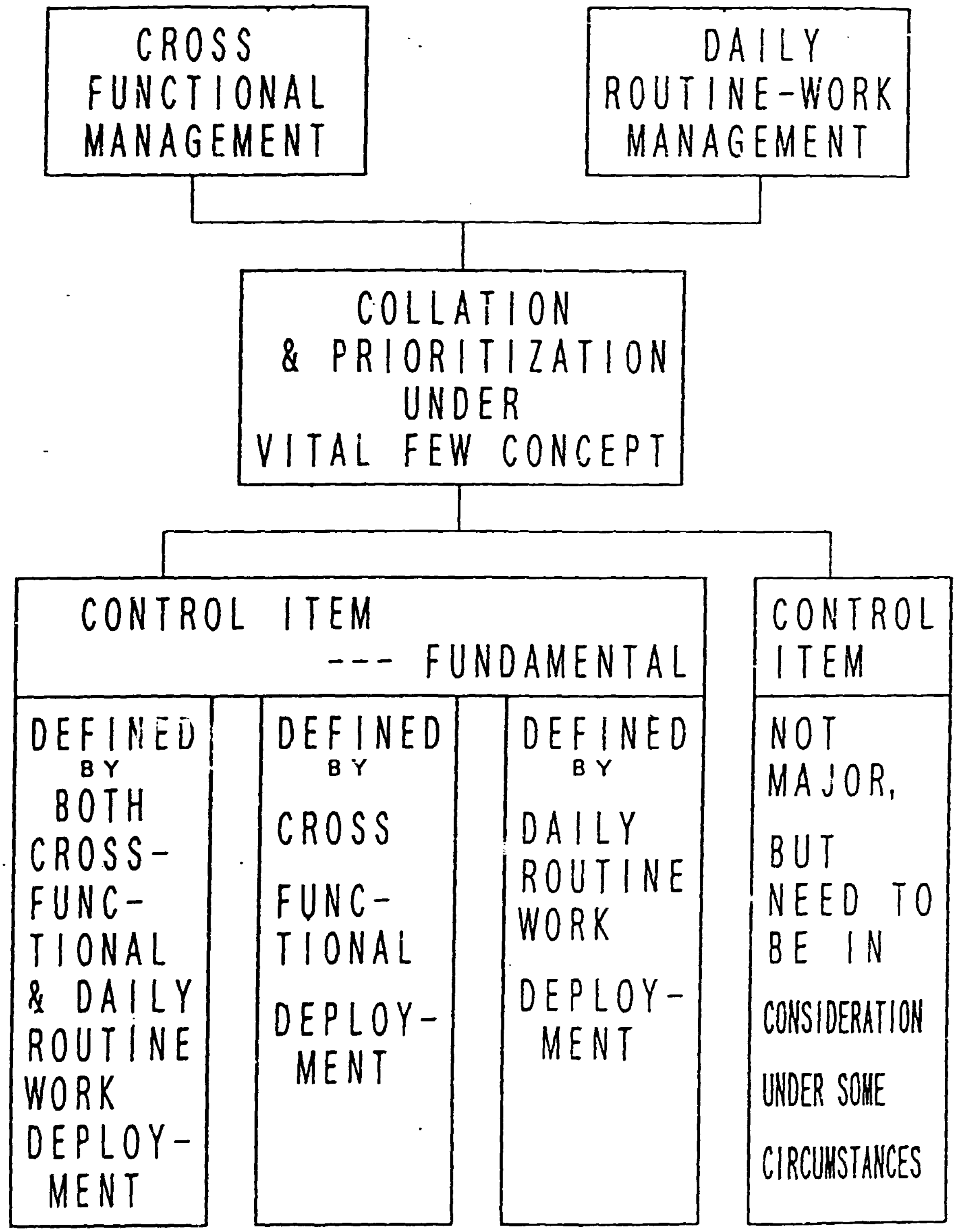
CONTROL ITEM IS CALLED AS

CONTROL POINT
CONTROL CHARACTERISTICS
CONTROL INDEX

CONTROL ITEM : RESULT
EVALUATION INDEX

CHECK ITEM : CAUSE
EVALUATION INDEX

COLLATION OF CONTROL ITEM



EVALUATION OF DAILY ROUTINE-WORK MANAGEMENT

level	CRITERIA	CHECK POINT
1	NOT CLEAR OFFICE DUTY	-available, but too old -not clearly stated for duty responsible
2	DUTY PRIORITY ARE NOT SPECIFIED	-not specified for critical, major, nor minor duty
3	DUTY GOALS ARE NOT ESTABLISHED	-can't evalute if accomplished or not
4	NO S O P	-can't have consistent quality-work
5	ANY DATA NOT AVAILABLE	-can't evaluate if conform with s o p requirement
6	HAVE DATA, BUT NO GOALS	-ditto
7	DATA ARE NOT VISUALIZED	-rather hard to visually evaluate at a glance
8	CORRESTIVE ACTION IS NOT FOR ROOT-CAUSE	-although dispersion are visible, but only probable causes are consider for corrective action, not for rootcause
9	NO RECURRENT PREVENTIVE ACTION TAKEN	-after corrective action be taken, no standardization are established
10	FULL IMPLEMENTATION OF RECURRENT PREVENTIVE ACTION, AND APPLIDE TO ANOTHER SIMILAR AREA AT THE SAME TIME	- TQC is fully implemented by P-D-C-A cyclic actions

CONTROL ITEM
IN PUBLIC SECTORS

QUALITY

FAILURE OBSERVATION NUMBER PER EQUIPMENT
FAILURE RATE PER EQUIPMENT
EQUIPMENT DOWN TIME
EQUIPMENT REPAIR/ MAINTENANCE TIME
EXCEEDING OBSERVATION ON ALLOWABLE REPAIR/MAINTENANCE TIME
FAILURE OBSERVATION NUMBER PER SPECIFIC PUBLIC-RELATED CUSTOMER
FAILURE RATE PER SPECIFIC PUBLLIC-RELATED CUSTOMER
CLAIM NUMBER
COMPLAINT NUMBER
COMPLETION RATE AGAINST INSTALLATION CONTRACT
DIRECT SOLUTION RATE AT OVER-THE-COUNTER SERVICES
INSTALLATION READINESS RATE
FAILURE RATE ON PAPER-WORK HANDLING WORKS
PREDICTION ACCURACY FOR CUSTOMER DEMANDS FOR SERVICES ETC

COST

BUDGET CONSUMING RATIO
INVENTORY RATE
STOCK RATE IN WAREHOUSE
COST RATIO AGAINST PLANNING
VARIATION RATIO AGAINST PLANNING
COST REDUCTION RATIO AGAINST PLANNING
CONSTRUCTION AND INSTALLATION COST REDUCTION RATIO AGAINST PLANI
LOAN RATIO TREND

SALES

EQUIPMENT POPULARIZATION RATE PER NATION HEADS
EQUIPMENT FEE DUE-IN RATE
PAYMENT REQUISTING DOCUMENT ISSUING RATE AS SCHEDULED
PROFIT RATE AS PLANNED
SALES TURN-OVER RATE AS PLANNED
EQUIPMENT QUANTITY SOLD
ACHIEVING RATIO AGAINST PLANNING
ACHIEVING RATIO AGAINST SALES TURN-OVER RATE

SAFETY AND ENVIRONMENT CONTROL

ACCIDENT HAPPENING NUMBER ON CUSTOMER AND EMPLOYEES
INCIDENT HAPPENING NUMBER ON CUSTOMER AND EMPLOYEES
ACCIDENT HAPPENING RATE AGAINST EQUIPMENT INSTALLED
CRITICAL ACCIDENT HAPPENING RATE AGAINST EQUIPLMENT INSTALLED
PUBLIC HAZARDOUS ACCIDENT HAPPENING NUMBER
ENVIRONMENT VIOLATING ACCIDENT OR INCIDENT HAPPENING NUMBER
POLLUTION VIOLATING ACCIDENT OR INCIDENT HAPPENING NUMBER
EMERGENCY READINESS RATE
GREENING CONTRIBUTION RATE
SOCIAL OR ENVIRONMENT CONTRIBUTION RATE

MORALE

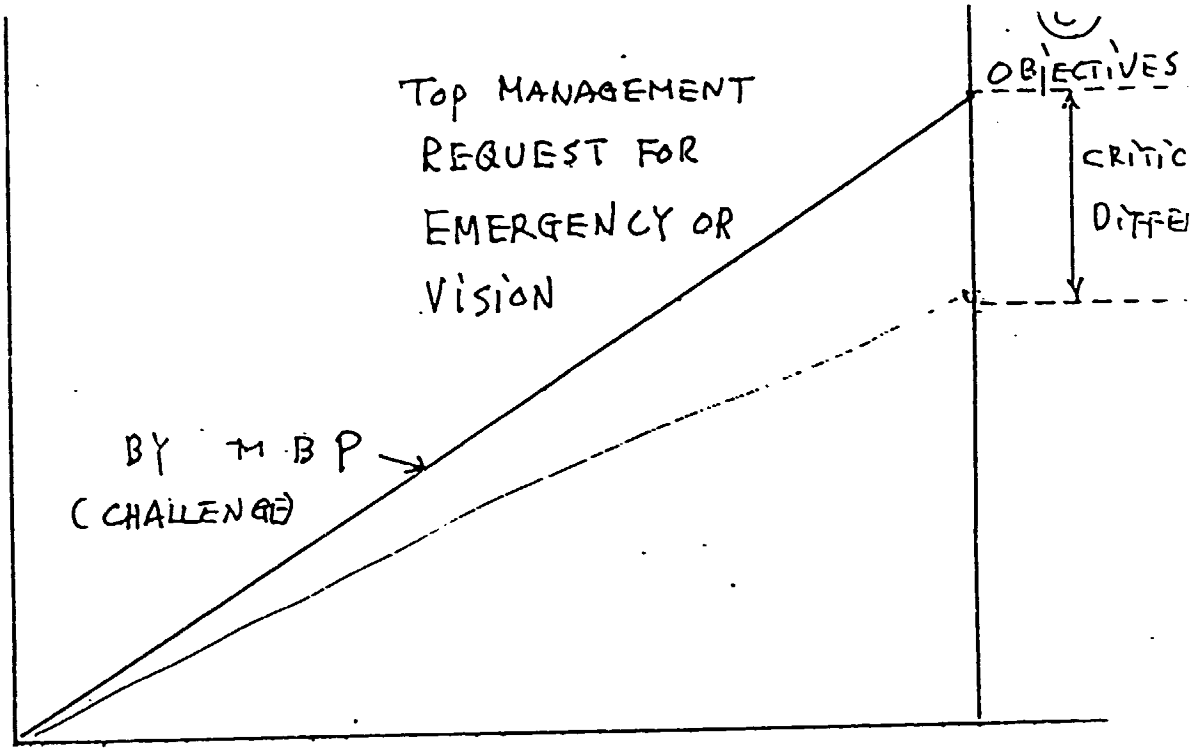
SUGGESTION PROPOSAL NUMBERS BY EMPLOYEE
STANDARDIZATION · COMPLETION NUMBER
IMPROVEMENT CASE PRESENTATION NUMBER BY STAFF ENGINEERS
NATIONAL CERTIFICATION APPROVAL NUMBER
TANGIBLE EFFECTIVENESS ACHIEVED BY ENGINEER
INTANGIBLE ACHIEVEMENT BY QC CIRCLE
PROJECT FINISHED NUMBER BY QC CIRCLE
OVERALL QC CIRCLE RATING

97

CONTROL ITEM TABLE

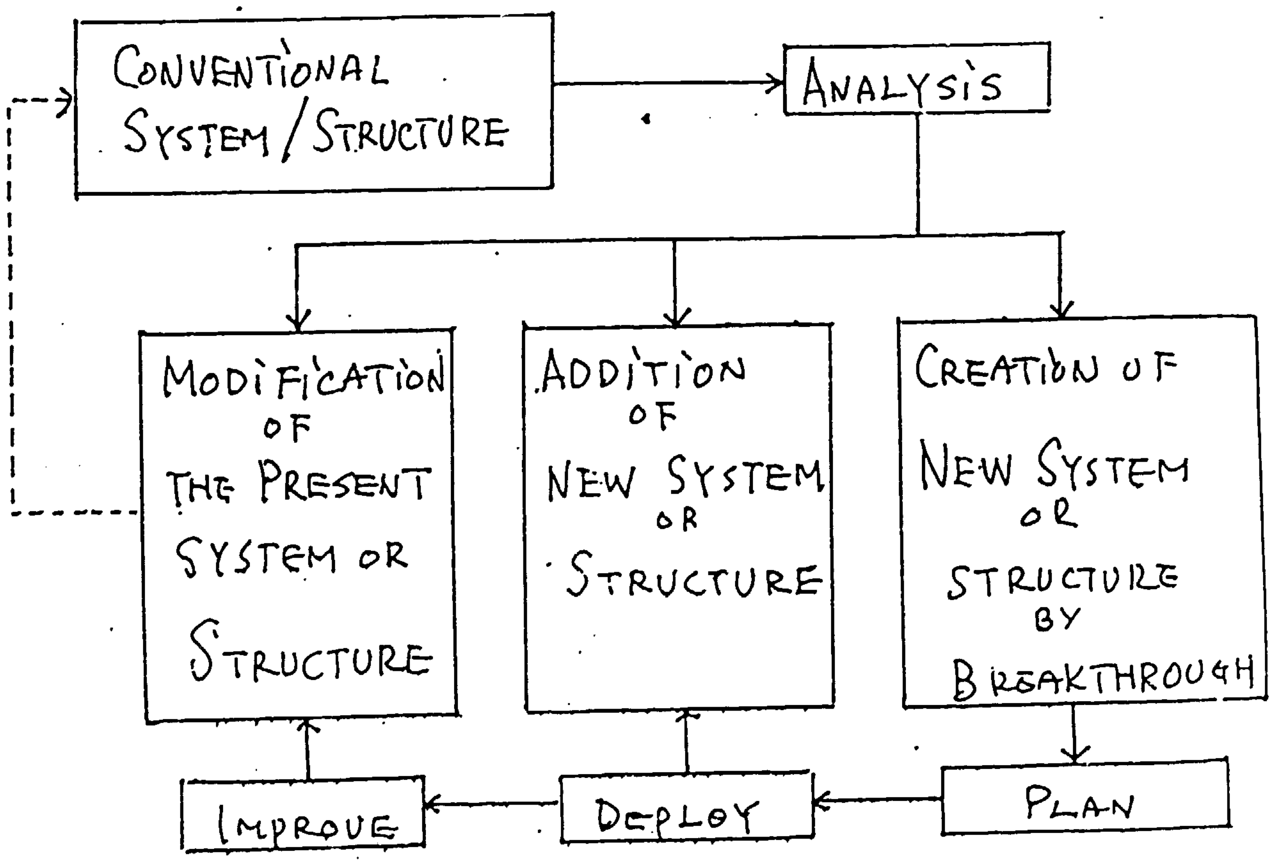
SEGMENT		FUNCTIONAL DUTY	OBJECTIVE FOR CONTROLLING	CONTROL ITEM: ITEM NOMENCLATURE	CONTROL ITEM: FORMULA	CRITICALITY	GOAL (ALLOWANCE)	HOW TO CONTROL: DOCUMENT	HOW TO CONTROL: FREQ	HOW TO CONTROL: ACTION
QUALITY ASSURANCE	1	CUSTOMER SATISFACTION -1. MACHINE-PLAYING -2 BATHING-BOOTH -3. POOL -4. TICKET COUNTER	(1) QUALITY ASSURANCE FOR CUSTOMER (2) QUALITY IMPROVEMENT AT OWN SHOP	CUSTOMER SATISFACTION RATING	TOTAL RATING / SURVEY NUMBER	A	TOTAL 0.65 (−0.06) -1. 0.55 (−0.05) -2. 0.65 (−0.06) -3. 0.75 (−0.07) -4. 0.65 (−0.06)	CONTROL GRAPH	MONTH	MGT
	2	CLAIM IMPROVEMENT	(3). SECURE CUSTOMER SAFETY	CLAIM REDUCTION	IMP/CLAIM ×100	A	100% (−20)	DITTO	"	"
	3	EQMT MAINTENANCE		MTN ACTION	MTN/DEFECT ×100	A	100% (±10%)	DITTO	"	"
	4	ACCIDENT/INCIDENT		INCIDENT RATE / 1,000 MEN	INCIDENT/PERSON ×100	A	0.015 (±0.001)	DITTO	"	"
	5	FIRE-FIGHTING EQMT		DEFECT CORRECT NUMBER	IMP/DEFECT ×100	A	100%	DITTO	"	"
PROFIT ASSUR	6	ENTRANCE FEE	PROFIT SYSTEM SUSTENANCE	SALES TURN-OVER ACHIEVEMENT RATIO	SALES/PLAN ×100	B	100% (+20% −10%)	DITTO	"	"
	7	PLAYING EQMT FEE						DITTO	"	"
	8	⊖ ADDITIONAL REPAIR/MTN COST	ADEQUATE BUDGET BALANCE	EXPENCE USING RATIO	PAY/BUDGET ×100	A	100% (+10% −20%)	DITTO	"	"
	9	⊖ ADDITIONAL OVERTIME ALLOWANCE		USING RATIO	SPEND/BUDGET ×100	B	100% (+10% −20%)	DITTO	"	"
EDUCATION	10	PROGRESS OF PART-TIMERS CAPABILITY	OJT EDUCATION	EVALUATION RATING	RATING/SURVEY ×100	A	0.55 (−0.05)	DITTO	"	"

(14)

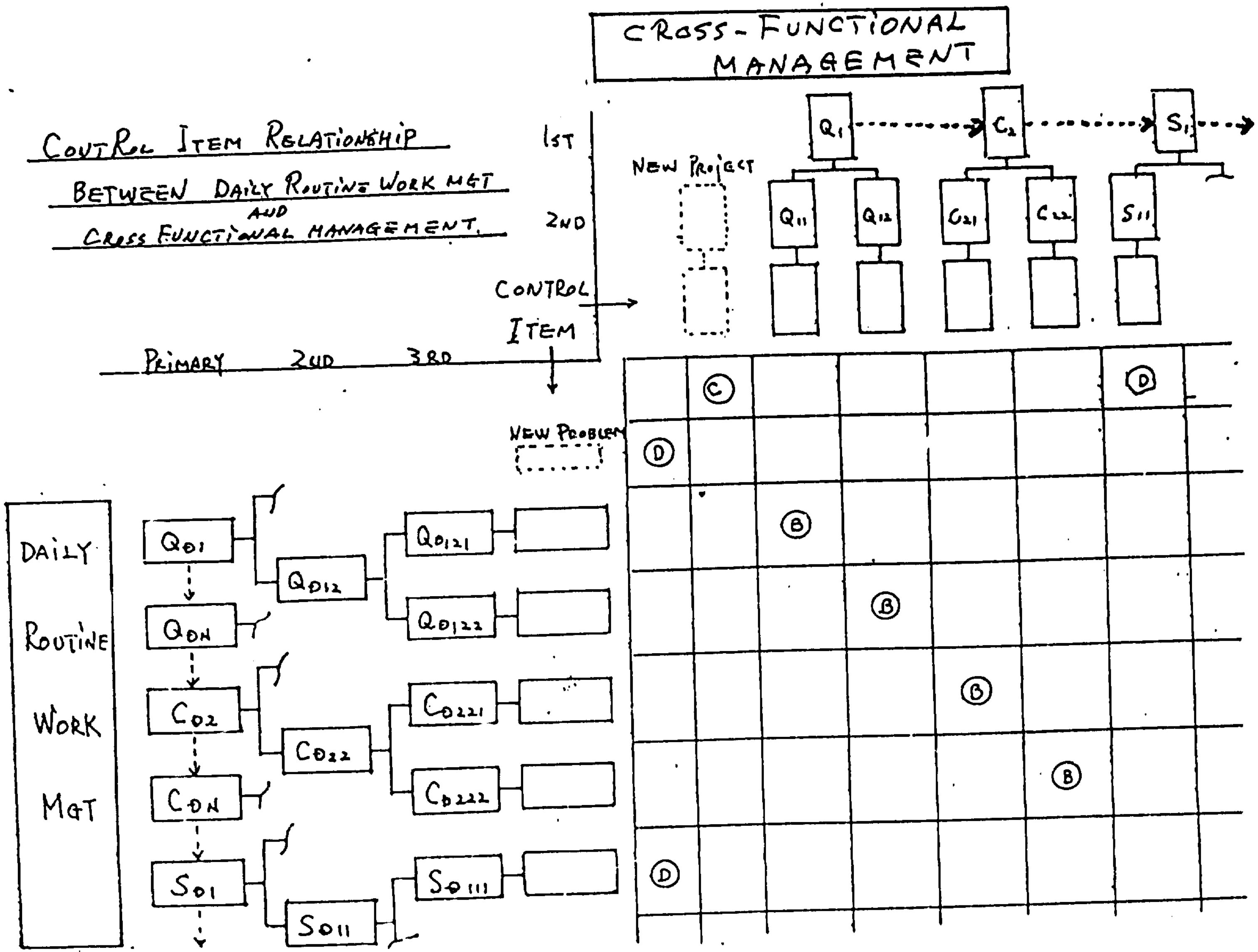


FOR:

(C) OBJECTIVE ACCOMPLISHMENT



Control Item Relationship Between Daily Routine Work MGT and Cross Functional Management



DATE: Jan. 11, 1995 JUSE TOKYO

SEND TO:	F. VANZOLINI, MR. MELVIN CYMBALISTA, SÃO PAULO, BRASIL
FROM:	UNION OF JAPANESE SCIENTISTS AND ENGINEERS (JUSE) 5-10-11 SENDAGAYA, SHIBUYA-KU, TOKYO 151 JAPAN NAME: I. MIYAUCHI TELEFAX:03-225-1813 PHONE:03-5379-1227 TELEX: 02322485 JUSE J
Total Page (Including This Sheet)	

[MESSAGE]

AA. A HAPPY NEW YEAR !! HOPE IT COULD BE A GOOD YEAR FOR ALL OF US.

BB. NOW, ABOUT 3-DAYS SEMINAR, WHEN OFFICE REQUESTED TO BE CONDUCTED IN MAY.

CC. HOWEVER, MY SCHEDULE IS SO TIGHT THAT WE WOULD LIKE TO CONFIRM AGAIN ON 10 APR (MO) TO 13 or 14 APR 95?

DD. IF IT COULD BE OK OR NOT ?

EE. HOPE WE COULD GO AS SUCH, THAT WILL SEND HAND-OUT COPY BY SEPARATE MAIL.

FF. SEMINAR WILL BE CONDUCTED BY ENGLISH BECAUSE HAND-OUT IS ENGLISH VERSION. HOWEVER, WILL YOU DECIDE AFTER LOOKOUT MY HANDOUT ? REGARDS,

I. MIYAUCHI
JUSE

日興通信株式会社
C&Cサービス事業部　　　　　　　　　　年　月　日
用品販売部　宛

商品名	数量	単位	納期	備考

納入先

会社名 ________________

住　所 ________________

TEL ________________

部　署 ________　担当 ________

請求先

会社名 ________________

住　所 ________________

TEL ________________

部　署 ________　担当 ________

FAX 03-5479-9432

TEL 03-5479-9443

7-5

2-WEEK TRAINING COURSE
FOR FCAV, BRAZIL
UNIDO PROJECT
(TF/BRA/92/B10, DP/BRA/92/004)

ROLE OF TQC FACILITATORS

Ichiro MIYAUCHI

COUNSELOR, J U S E

UNION OF JAPANESE SCIENTISTS AND ENGINEERS

UNION OF JAPANESE SCIENTISTS AND ENGINEERS
(NIPPON KAGAKU GIJUTSU RENMEI)
5–10–11, Sendagaya, Shibuya–ku, Tokyo 151, JAPAN

Table of Contents

1. Preface

(A) Prior to implementing TQC into each enterprises, it is very important for top management to identify their specific necessity of TQC implementation schemes by their own clear-cut words for every employees easy understanding as shown in Fig. 1. According to our experiences, most commonality for TQC implementation triggers in Japanese industries are how to strengthen their Co's constitution for survival under upheaval environments exposed by economical, political, international and technological changes or innovations through break-through, under top management commitment for TQC implementation, as shown in Fig. 2 and Fig. 3.

The "Strengthening of Co's Constitution" means whenever, whatever, and wherever any unexpected nor undesirable changes takes place. The Co. can respond and survive such critical or risky circumstances to by TQC approaches.

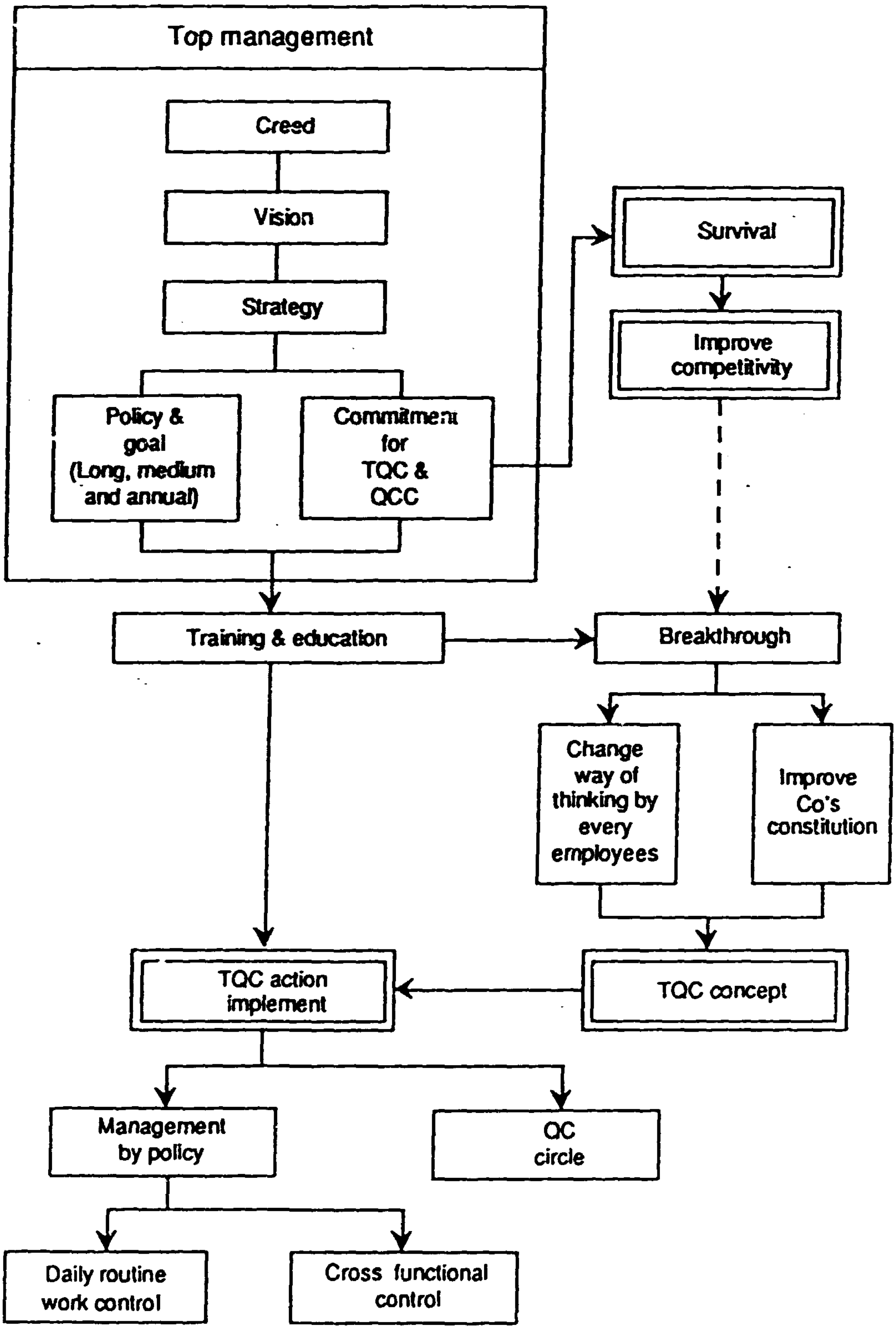


Fig.1 Top Management Commitment

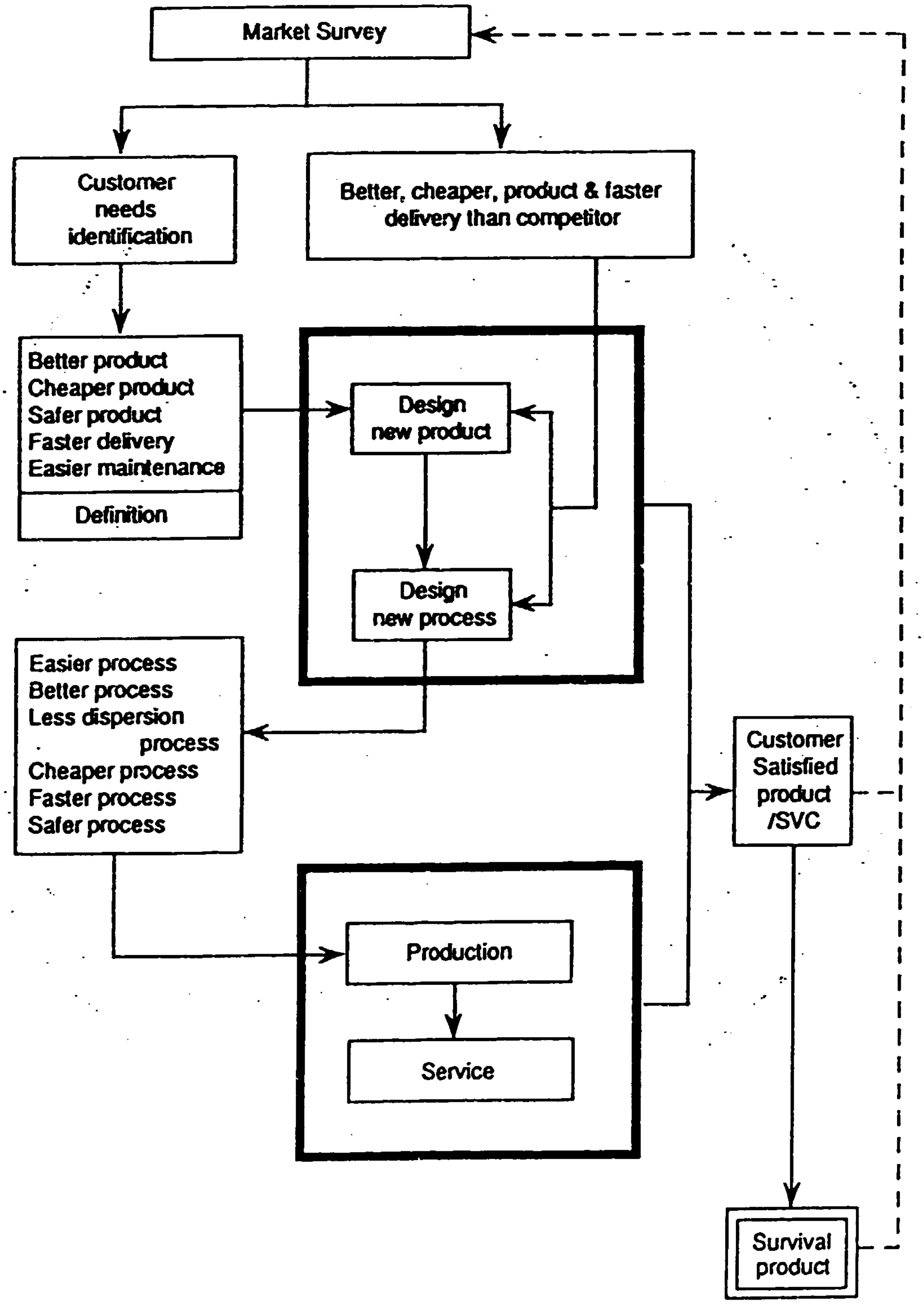


Fig. 2 Survival & Competitivity

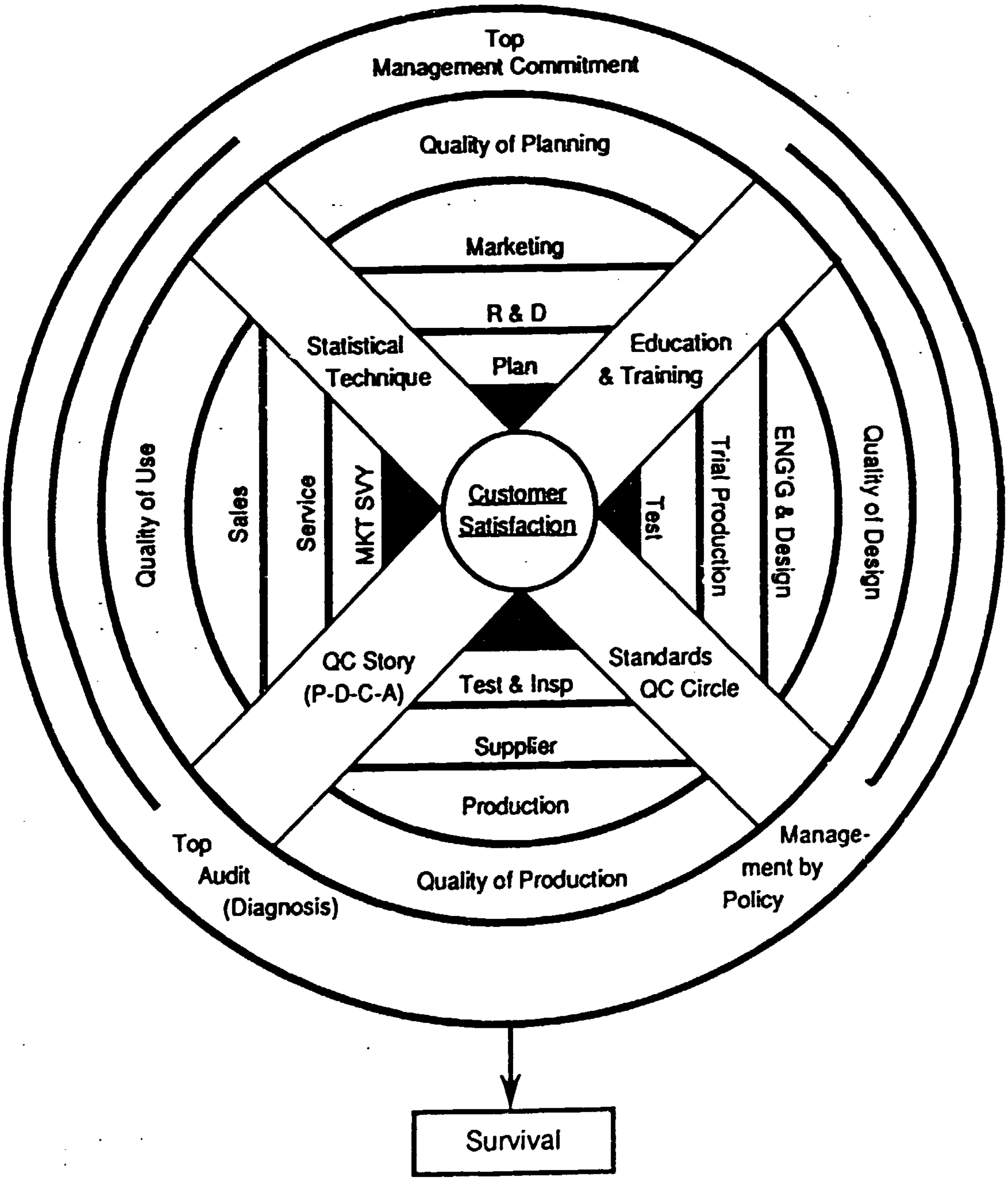
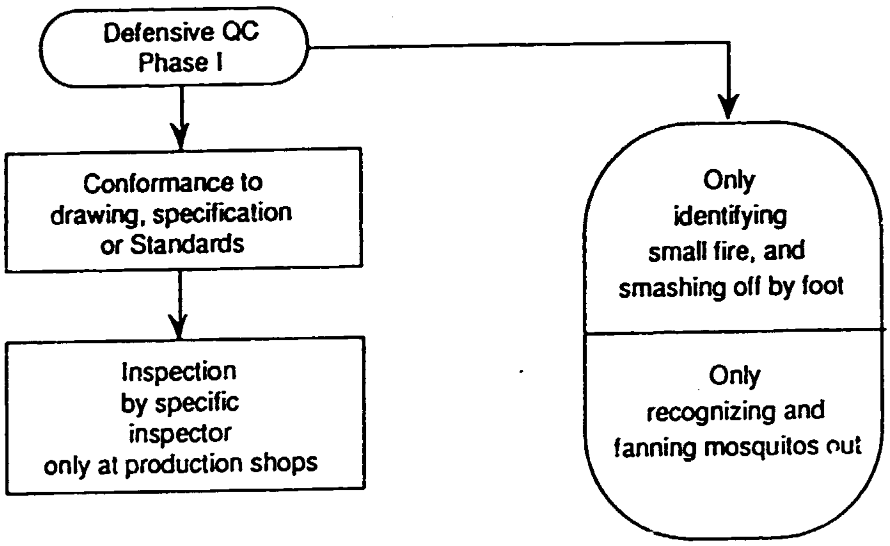


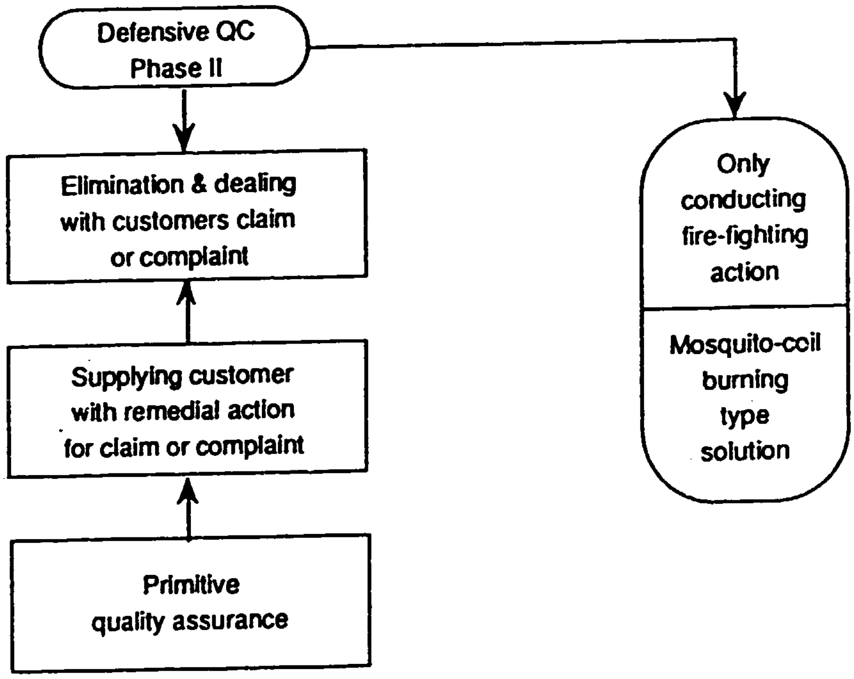
Fig. 3 Total Quality Control (TQC) Implementation Flow

(B) While implementing TQC, our experiences have revealed so many kinds of steps to be passed through until gaining full survival programs.

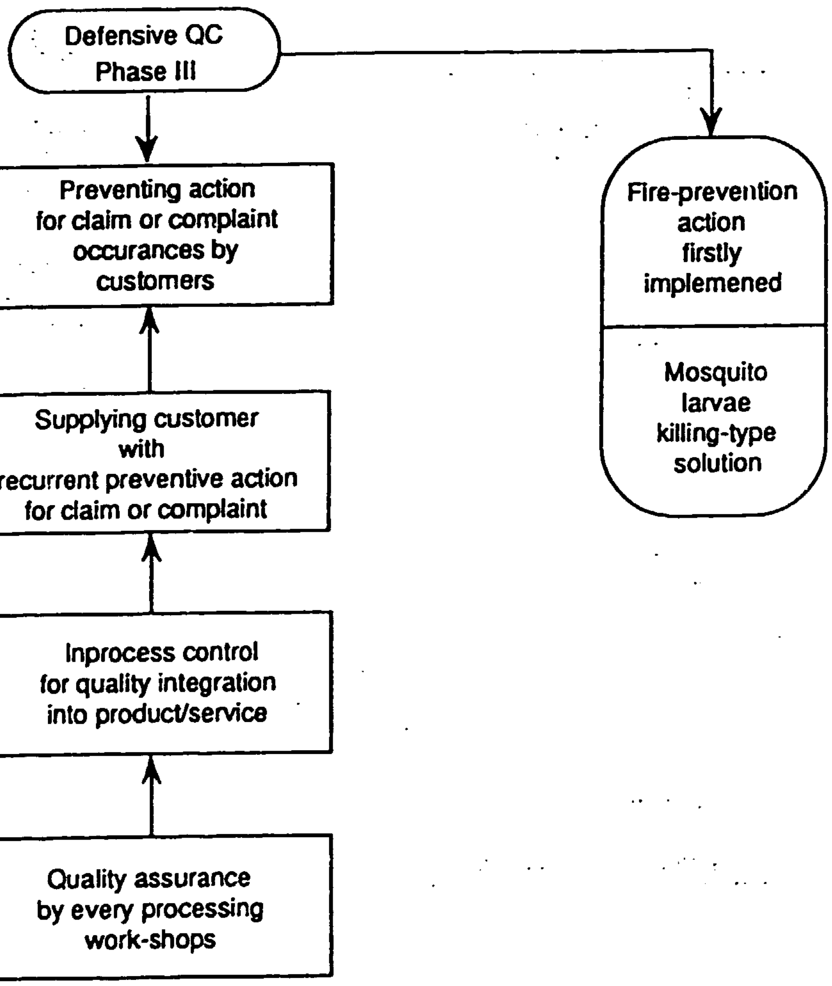
(1) Defensive Quality Control, Phase I
The defensive quality control is previously called as "Product-Out" quality control which could be illustrated in the followings,



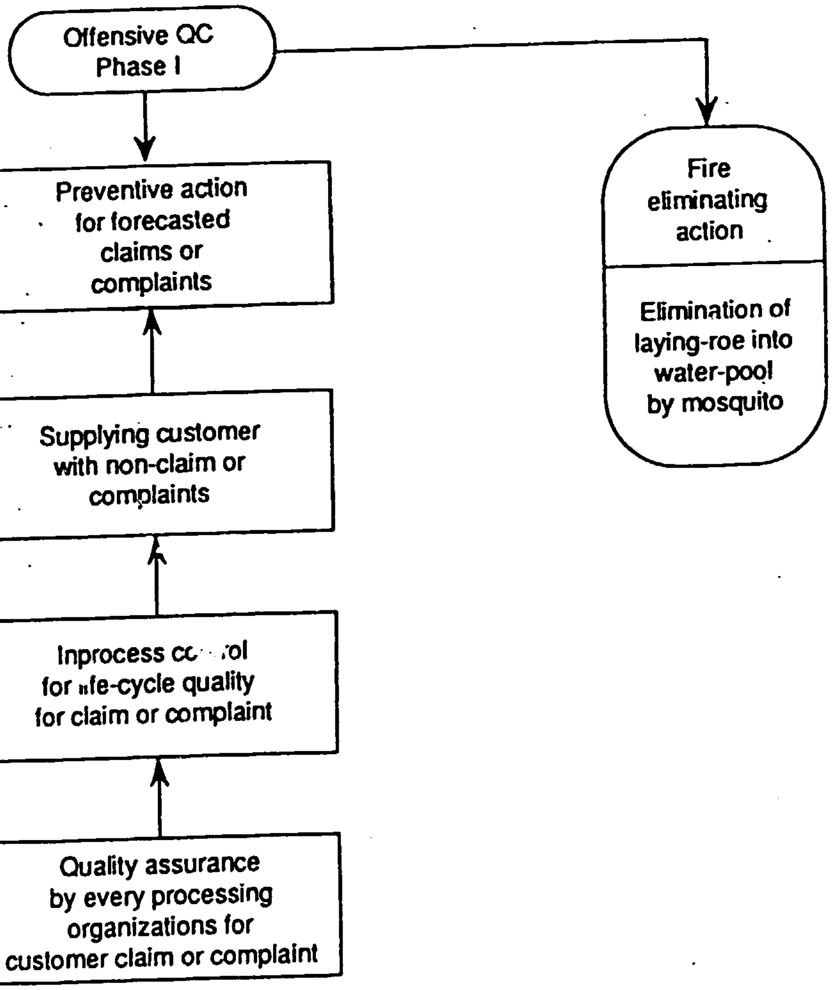
(2) Defensive Quality Control, Phase-II
(Mainly, claim or complaints handling)
In this phase there is slight awareness of customer satisfaction/needs by only dealing with customers "Claim" or "Complaints".



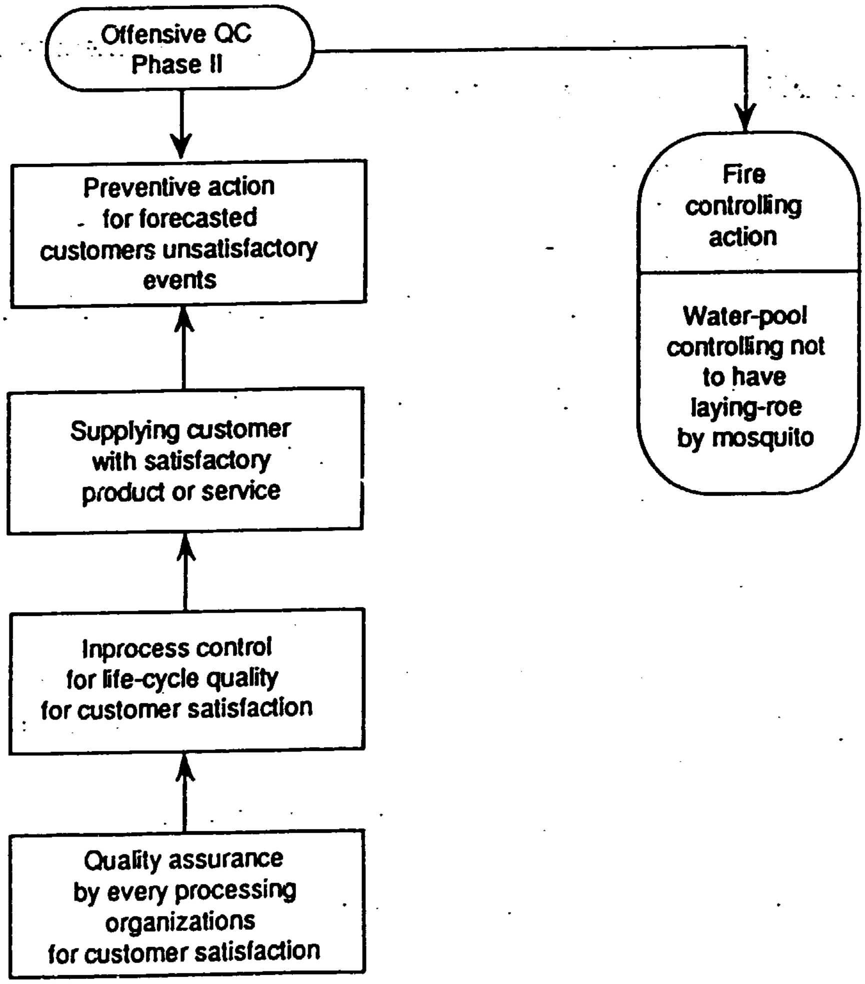
(3) Defensive Quality Control, Phase-III
(Prevention of claim or complaint)
This phase is based on quality control concept, which is prevention philosophy for customer claim or complaint



(4) Offensive Quality Control, Phase-I
(Prediction and elimination of claim or complaints predicted)



(5) Offensive Quality Control, Phase-II
(Prediction and elimination of customers unsatisfactory events predicted)



2. TQC Conceptual Operation (Management)

2.1 General Expression of TQC concept

TQC conceptual operation (Management) are generally explainable by following stated expression:

- Don't get mad.
- Don't shout.
- Don't exit.
- Speak with data, consider with data, and take action with data.
- QC means nothing but dispersion control.
- Customer is not God, but a king or a queen.
- Don't fight with customer who is a king or a queen.
- Listen first, instruct later.
- Not appreciate happy-ending report or story.
- Control not by result, but by inprocess.
- Any action and report must be followed by QC story.
- If only inprocess is fully controlled, no need for any final inspection (Inspector).
- QC is not conforming to spec nor drawing, but to customer demands (needs).
- Don't make any same mistakes.

2.2 TQC Concept

First of all, TQC concepts are necessary to explain how they are constituted, as follows:

(1) Market-in (Customer oriented) concept
(2) "Quality First" concept
(3) "Vital Few Oriented Action" concept
(4) "Fact & Data Appreciation" concept
(5) "Process Control for Quality Assurance" concept
(6) "Dispersion Control in Process" concept
(7) "Next Down-Stream Shops are Customer" concept
(8) "Upper Stream Control" concept
(9) "Recurrent Preventive Action" concept
(10) "Respect Employee as Human Being" concept
(11) "Top Management Commitment" requirement

3. Detail Explanation of TQC Concepts

3.1 "Market-In" (Customer Oriented Action)

"Market-In" concept can be interpreted as follows:

(A) "Empathy" oriented behavior (You put yourself in his place, concept)

(B) Provide only acceptable & affordable product/service to customers

(C) Not supply "Product-Out" product/service

(D) Customer is not God, but a king or a queen.

3.2 "Quality First" (Customer full satisfaction)

This can be interpreted.

(A) Product/service quality have the highest priority in business management, which have much higher predominancy than sales turn-over increase, cost reduction, productivity improvement, market share progress, etc.

(B) Quality is comprised of not only just product/service quality, but of price, cost, time, quantity, safety, employees morale and every employees outputs in daily routine works, etc.

C) Customer voice must be appreciated as "God-Whisper".

3.3 "Vital-Few" Oriented Action - Brain, Time & Fond Constraint

This can be interpreted, as:

(A) Human being has only one brain, that no brain spaces be available for more than one concentration at a time, unless a genius.

(B) A person who is grumbling about work piled up is mostly spending not "Vital Few", but only "Trivial Many" dealing with.

(C) Identify and isolate "What items/issues deserve enough attention to deal at this time, under brain-work, time-and fund-constraints".

3.4 Fact & Data Appreciation - Scientific Approach

This can be interpreted, as,

(A) Rush to the place where it happened.

Verify the fact (Failure, defect, claim or complaint) on the spot.

Take action of every possible counter-measures at that time.

(B) Speak
Consider — with Data
Take action

(C) Collect specifically data which explains the facts as shown in Fig. 4.

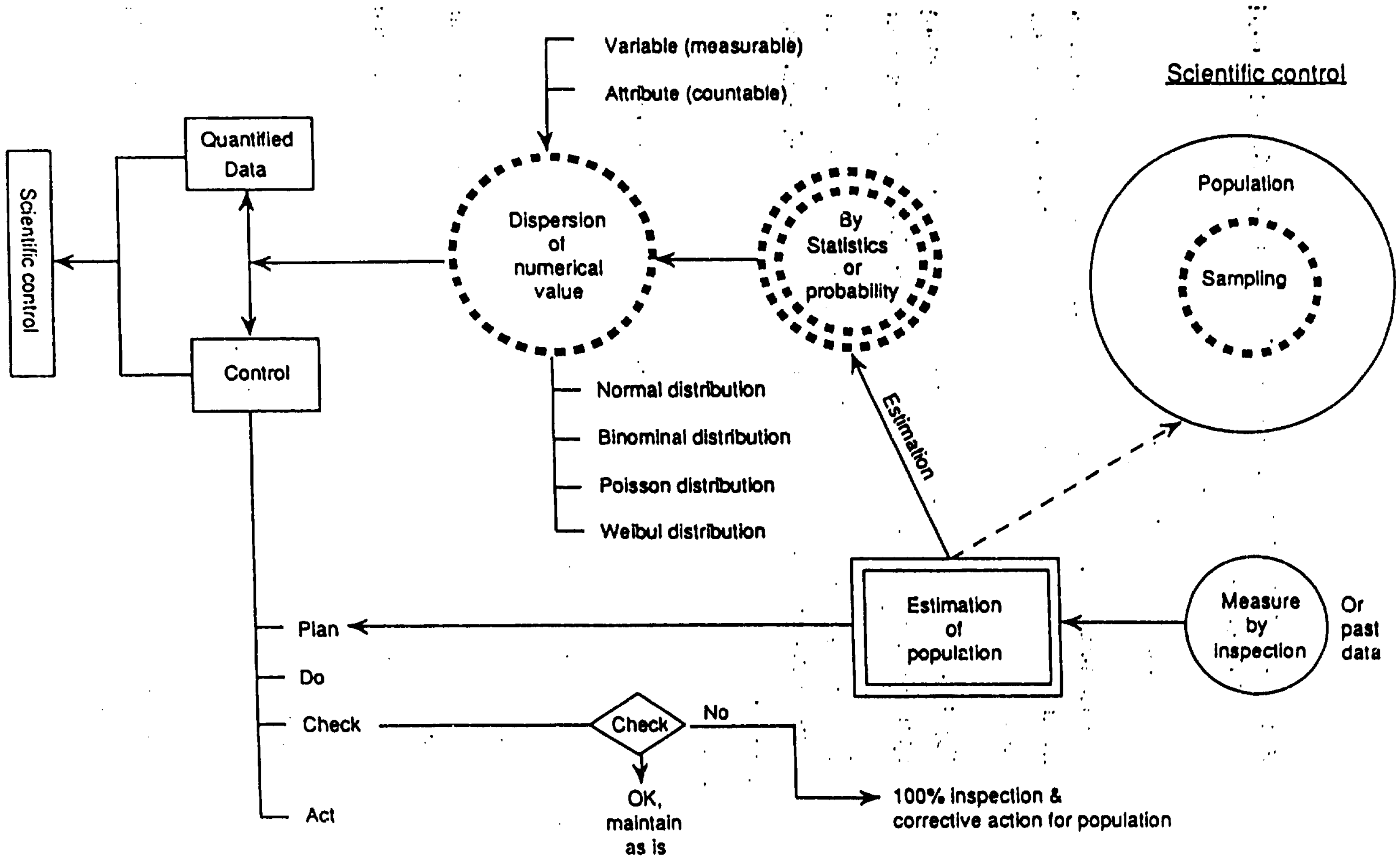


Fig. 4 Data Source

3.5 Process Control (Prevention plan & implementation)

Process control means that if only every employees at every stage in every organization are doing right at the first time and every time to conform with specific SOP, drawing, specification or processing standards by self-check or self-controlling methodology.

(A) Under product life-cycle concept, every stages are to be called inprocesses as for customer, shown in Fig. 5, which are required to assure their accomplishment for customer both in-house and real out-side customers.

(B) At the same time, each stages have their own sub-processes for achieving of their responsibilities, as shown in the followings,

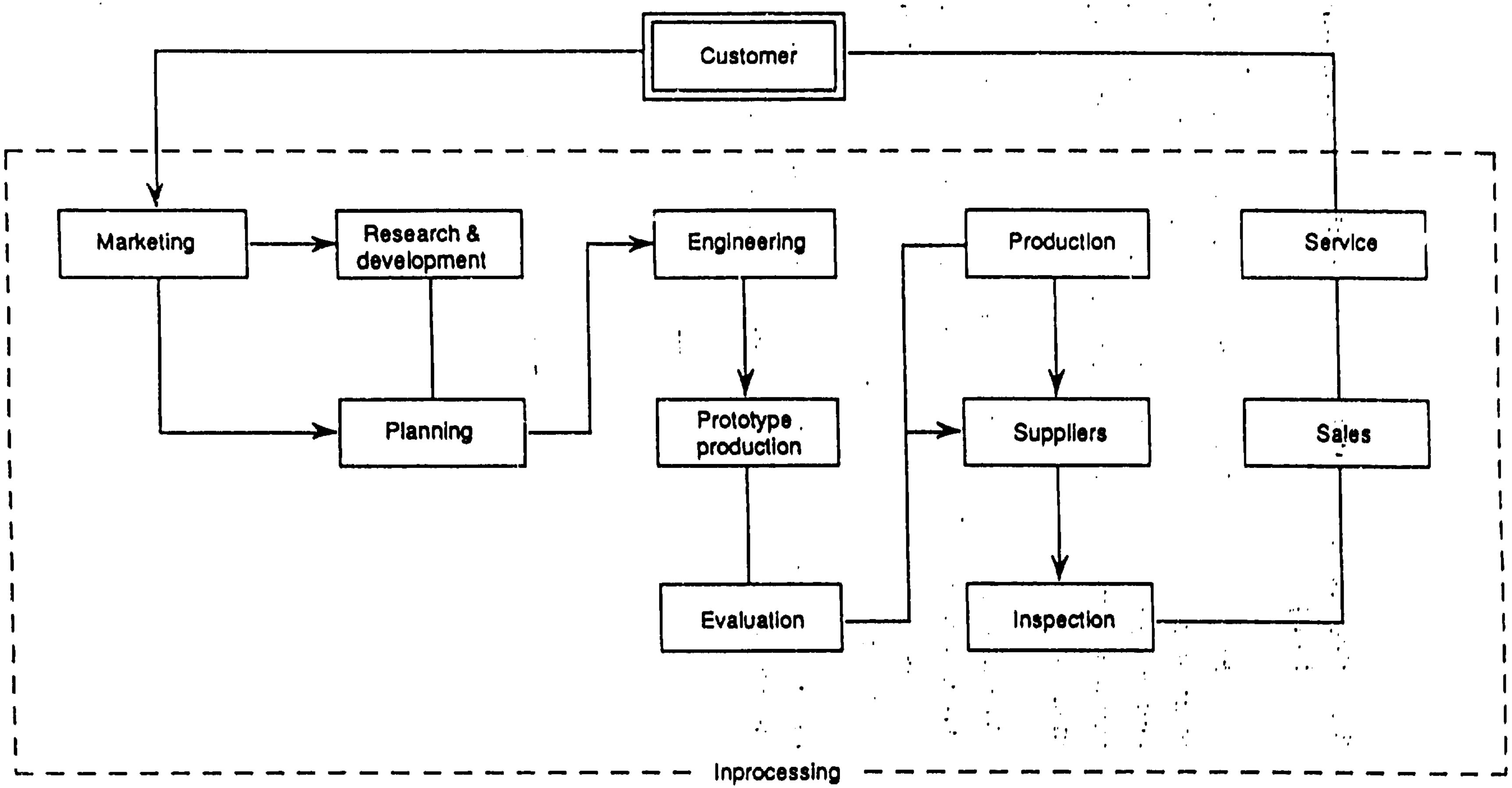
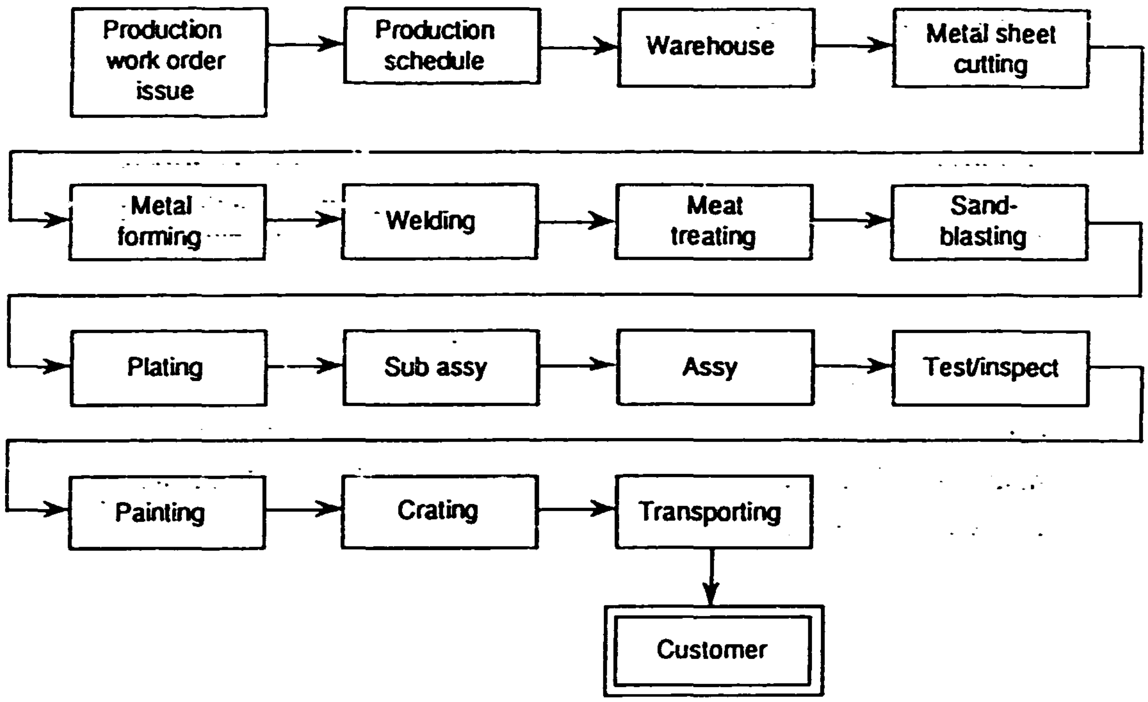


Fig. 5 Product Life-Cycle

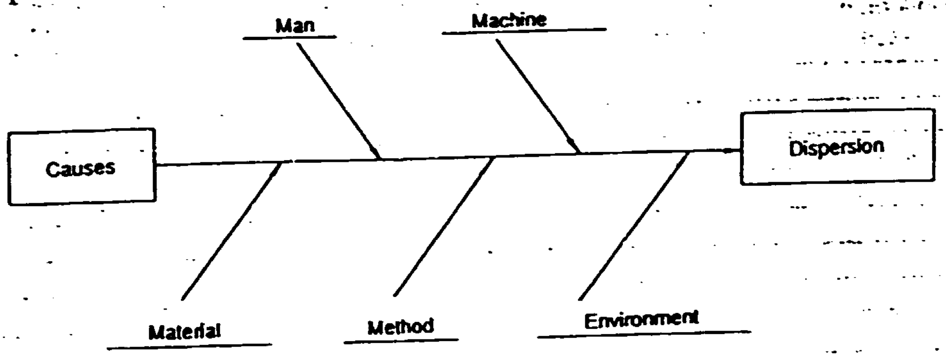
in production stage, various processings are also



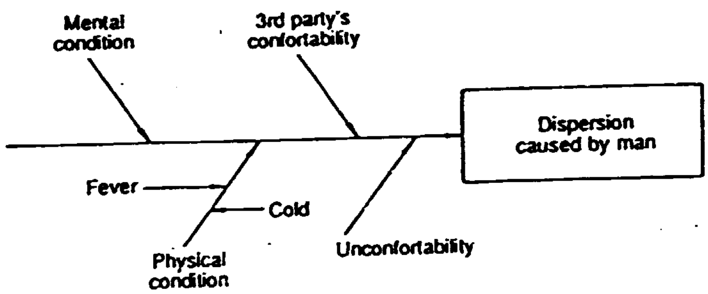
located as inprocesses by different organizations.

3.6 Dispersion Control

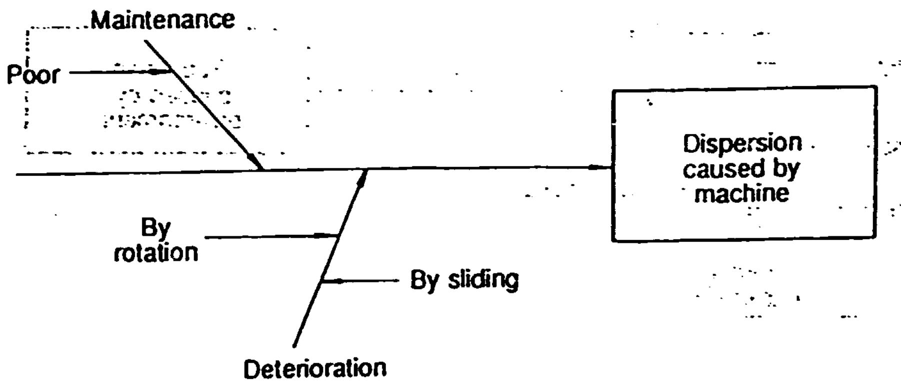
Today's quality control is nothing but how to control dispersion which are happened at various

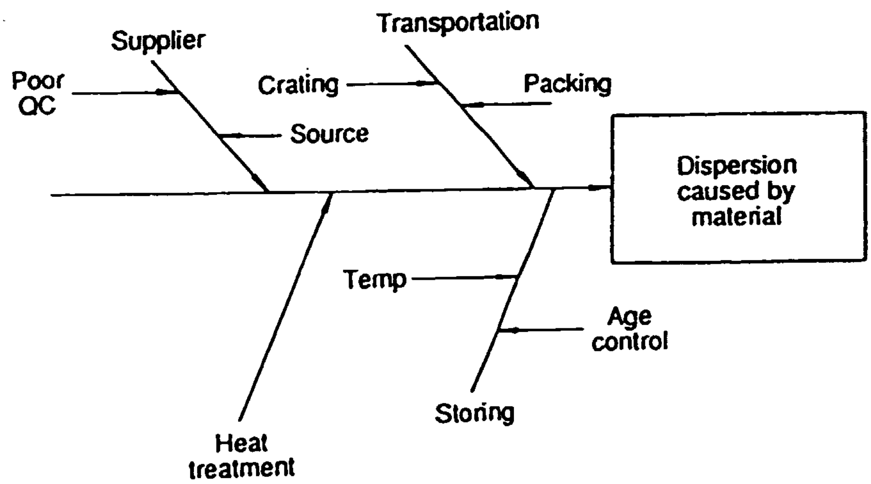


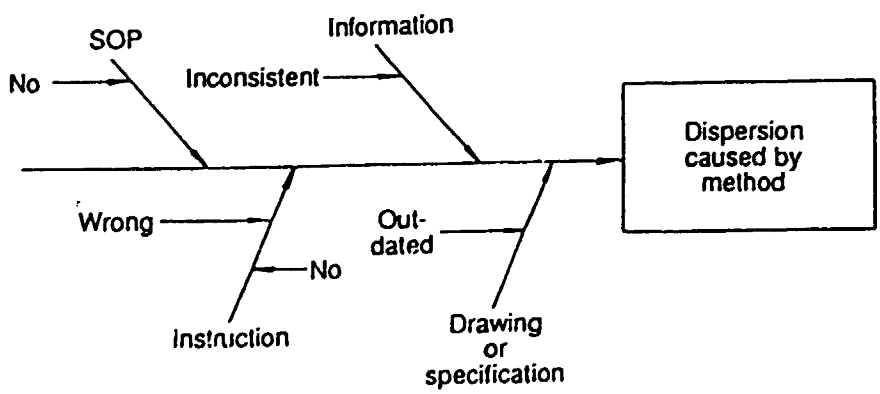
causes — such as man, machine, material, method, and environment (4M1E factors) as shown in the aboves. These 4M1E factors are independently.

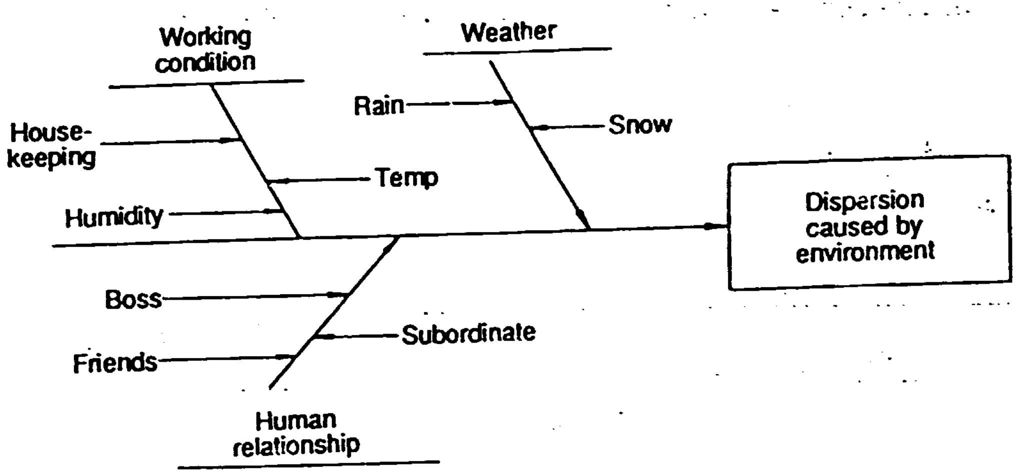


or interactionally dispersed by as shown in the following:








Working condition
Weather
House-keeping
Humidity
Temp
Rain
Snow
Dispersion caused by environment
Boss
Friends
Subordinate
Human relationship

3.7 Next Down-Stream Shops are Customer

Customer is a King or a queen, as mentioned before however, except for marketing or sales personnel, most of employees have no chance to physically contact with and deal with customer that this concept is rather impossible to understand and to follow by the inprocessing employees. To solve these difficulty, the next down-stream shops are treated as customers, that is, for in-house customers their outputs must be accepted by the next down-stream shop operators.

Accordingly, through inprocess control concept, upper stream-shop operators are required to assure the quality of their work for the downstream customer.

3.8 Upper Stream Control

As shown in product life cycle diagram in para 5, marketing organization is located to the nearest to customers that unless they are recognizing their role and responsibility which are to have customers need/requirement for every down stream shops, such as planning, engineering, quality control or production, the whole down stream shops could not identify how to plan, design, produce or quality assure for customers. The marketing is situated at an entrance gate for quality. Accordingly the upper stream shops' responsibility such as not only marketing, but planning & design are fully understood and implemented into their organizations. To implement them, it is necessary to consider and prepare for,

(A) Establish new product development and quality assurance system flow charts to integratedly control from upper stream o lower one.

B) Establish quality deployment system and identify "Real Quality" for customer satisfaction.

(C) Evaluate results at every predetermined stations to identify if goals for every stations are achieved or not. If found non-achievement, don't neglect it until correction be made.

(D) Predict any difficulties or problems at planning, R & D, design and prototype production stages, o prevent from any troubles at down-streams.

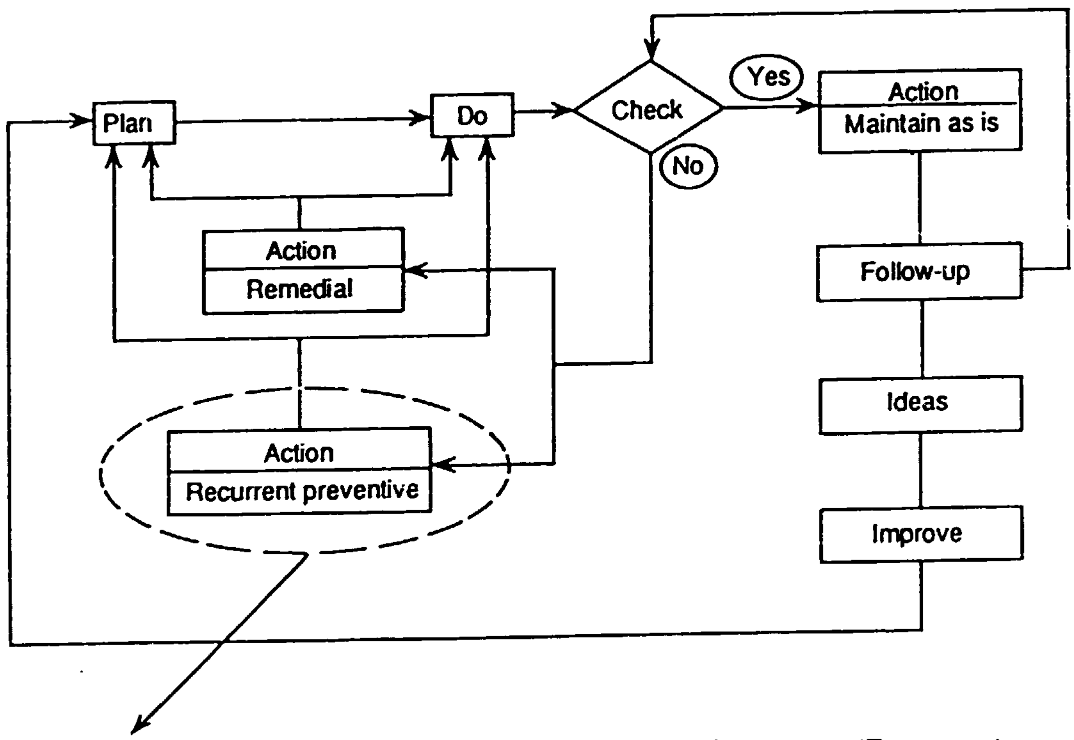
(E) Improve processing flow by improving of each processing of development phase.

(F) Identify root-cause for difficulties or problems by chasing-up to upper stream organizations.

(G) Prepare various SOP, flow chart, process standard, regulation or check sheet for prevention and assurance for customer satisfaction.

3.9 Recurrent Preventive Action (Repetitive failure is shame)

Under Plan-Do-Check-Act (QC Story) process, the following stated flow must be followed by every employees,



and when found something wrong at Check stage, "Recurrent Preventive Action" are a must for Plan or Do stage for not happening again by the same cause, under "Repetitive Failure/ Defect is Shame" concept.

3.10 Respect Employees as Human Being (Employees are precious assets.)

It is a time for top management to reconsider the famous behavior scientists concept as such McGregor's Y-Assumption, Maslow's Hiarachy, or Hertzburg Survey, which are summarized as follows. To handle and treat employees for adult-human being.

A) Provide task variety to avoid boredom
B) Enlarge the job to meet skills and ability of worker
C) Provide feedback on performance
D) Provide job closure or job identification
E) Self-control of significant aspect of the work
F) Opportunity to learn new skills
G) Participation in problem solving, planning and controlling

3.11 Top Management Commitment (Employees full participation)

Top management is necessary to declare definitely why TQC is a must to implement while explaining of

A) Co's situation,
B) Co's vision and strategy with his creed
C) Competitors
D) Technological or technical innovation status

why QC circle is necessary under TQC concept.

To have every employees participation or involvement for survivability and prosperity to subjugate present upheaval ages.

4. TQC Implementation Action

TQC is now ready to implement by the following stated actions:

(1) Education and training — Understanding

(2) Establishment of Standards — Consistent quality

(3) Implementation of "Plan-Do-Check-Act" concept — Control cycle – Improvement and maintaining cyclic action

(4) Implementation of "Management by Policy" methodology — Commitment & Deployment

(5) Utilization of statistical method — Systematic & scientific way

(6) Avoid/diagnosis by top management — Leadership of top management

(7) Q C. circle activity — Involvement

5. "QC Story" Processing

It is necessary for TQC implementing Co's employees to explain their actions by sound processing sequences, as stated below, which are called "QC Story" based on Plan-Do-Check-Act cycle.

(1) Establishment of project
(2) Identification of present status
(3) Analysis of data & fact obtained
(4) Isolation of root-cause(s)
(5) Establishment of counter-measure(s)
(6) Execution of counter-measure and evaluation of result(s) obtained
(7) If effective, standardize it as permanent fix. If not, repeat Para 2 to Para 6.
(8) Identification of residual problem and future program

These sequential processings are called as "Sound", as shown in table 1, because,

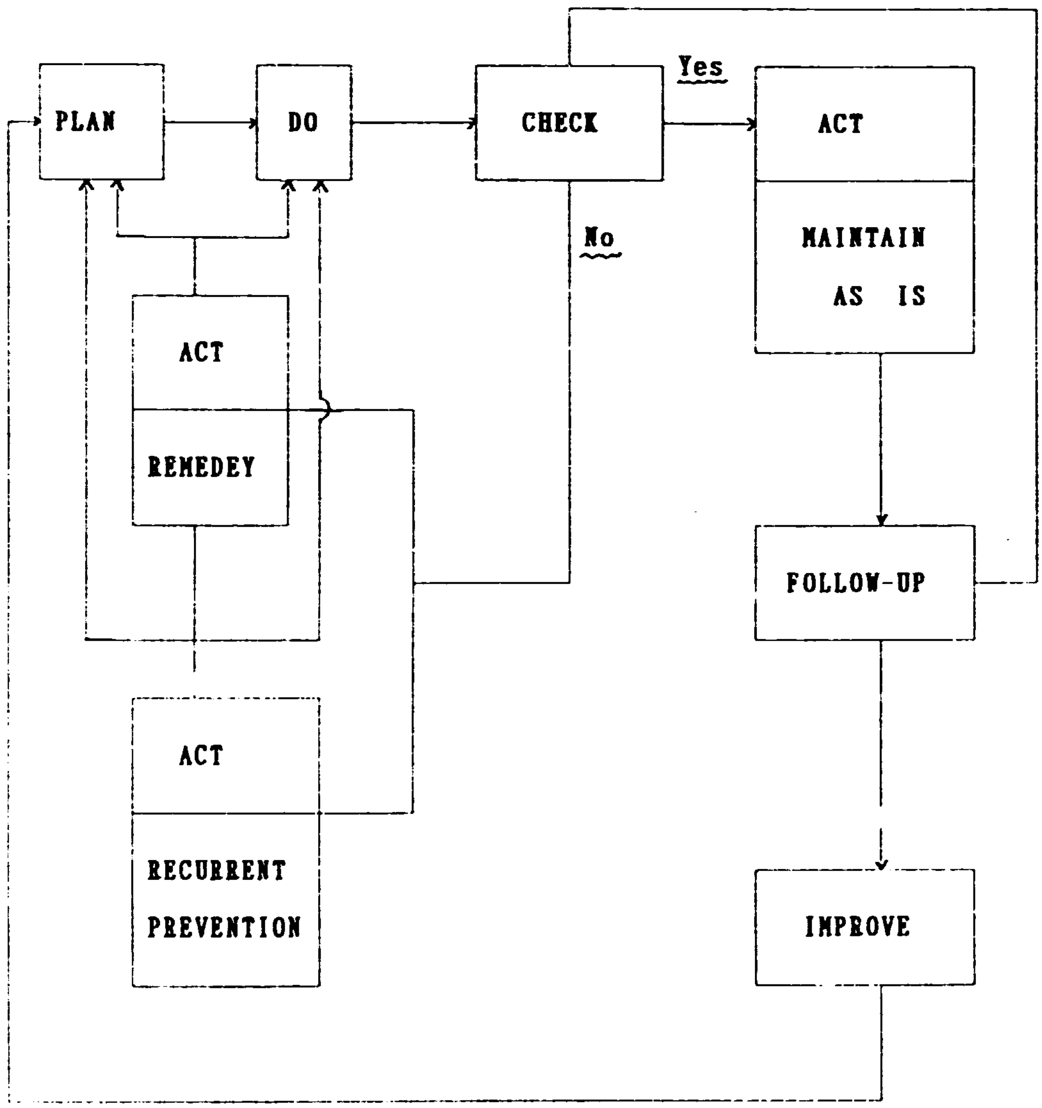
1) Clearly to state why this project is necessary to tackle at this moment, which means priority
2) To analyze situation & environment for project accomplishment based on data/fact
3) To clarify relationship between cause(s) and result(fact), and for project accomplishment, to isolate probable contributions
4) To establish counter-measure(s) for probable contribution by thorough studying of various alternatives planned for counter measures

The detail processing procedures will be explained in the succeeding sub-paragraphs, and typical reporting model is explained in Table 2.

Table 1 Non-QC Story Approach

Quack Doctor Approach		QC Story Approach
Patient complained "Head-ache" at dispensary	1	Found defects in product fabricated.
Without, any medical examination for why "Head-ache" is occured.	2	Without, any study or analysis for why defect is occured by foreman.
Prescribe medicine for "Cold".	3	Change operator.
Relieved of Head-ache	4	Disappeared of defect.
Doctor convinced himself "Head-ache caused by cold".	5	Foreman convinced himself "Defect caused by bad material".
By prescription, doctor examined patient	6	By result (defect), foreman looked for cause.
Temporarily, head-ache looks "Healed" but may happened "Head-ache" again in future	7	Temporarily, defect looks corrected but may observed "Defect" again in future
Patient visited doctor again, but doctor change medicines without examination	8	Foreman is surprised, and change operator, or machine still w/o root cause isolation.
May be cured by this prescription, but he could not explain why gone that his medical skill would never be improved.	9	May be temporarily corrected, foreman could not identify why defect be gone that his problem solving capability would never be improved.

Table 2 QC Story Flow Chart



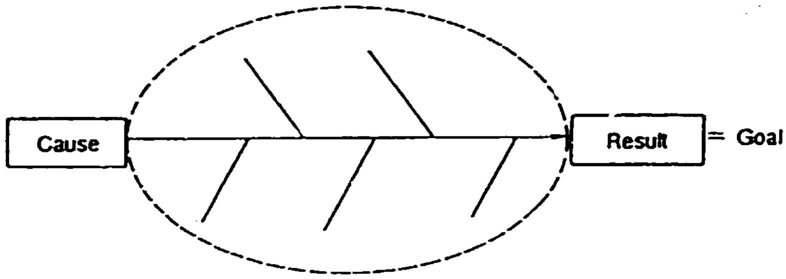
5.1 Establishment of Project

(A) Select quantifiable/measurable goal for project accomplishment

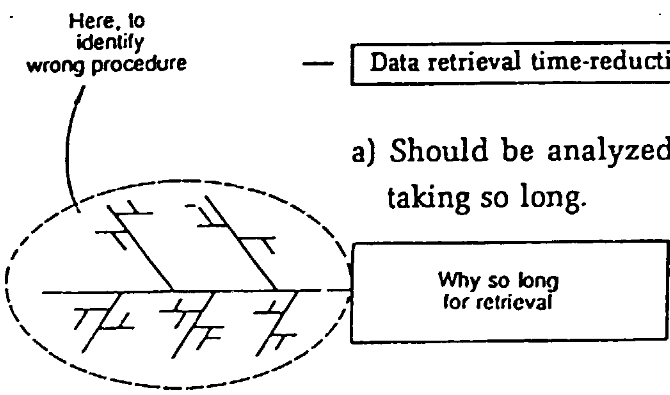
— Data retrieval time with 10'

— Repaint finish reduction less than 50%

(B) Goal selected must be located on result (Why so bad, or why to happen approach), not in cause area.



(C) Counter-Measure ("How To" procedures) should not be selected as goals, but only result ("Why To" procedures)

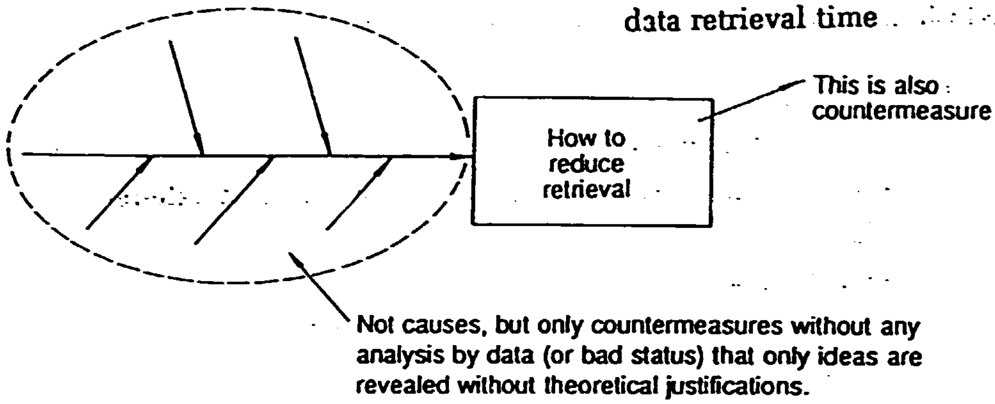


— Data retrieval time-reduction

a) Should be analyzed why taking so long.

But,

a)' If started, how to reduce data retrieval time



5.2 Justification of the Project Tackling

(A) Clarify why the project is necessary to tackle

(1) By data,

- is it controllable or uncontrollable?
- is it quality, cost, quantity, time, safety, or morale-related?
- which area?
- what kinds of problems — Sporadic / Correctable
- when was it observed?
- is it potential, hidden or exposed?
- is it tangible or intangible?

(2) By criteria

- is it normal or abnormal through control-chart limits?
- is it within or out of specification or drawing requirement?
- is it conforming or not to top management goals specified?

(B) Determine

(1) Date to be finished (— By the end of Jan. 1990)

(2) Goal to be accomplished (— 20% reduction of failure rate)

- Intangible effectiveness
- Tangible effectiveness

(— How much be anticipated to be saved.)

5.3 Identification of Present Status

(A) Summarize any available data, or collect new data to identify degree of the present status (how good or how bad), by:

- Quantitative data

or

- Qualitative data

(Don't miss, customers information (data) are mostly belonged this category)

(B) Justify if data collected/summarized are reliable enough to use, by

- Validation of hardware — Product, equipment, machinery related with Project.
- Visitation of place or area related with Project
- Verification of phenomenon (How good or how bad status).

While assuring if same or similar kinds of data can be collected.

(C) Stratify any data, as shown in Fig. 3, by 5W1H approaches:

By when?	By What?
By where?	By why?
By who?	By How?

(D) Study the stratified data if any dispersion or variation be observed.

- By graphication as possible as can for easy observation as shown in Fig. 6, against
  - — Specification or drawing criteria
  - — Control limit
  - — Goals specified by top management or own's senior MGT
- If dispersion found,
  - — Try to find any other similar dispersion by comparing with another case-studying for confirmation of this kinds of dispersion.
  - — These case studyings are recommended to find at least 2 or more up to 5 cases.
  - — It is necessary to hasten for data collection until locating right case-studying
  - — If only one-case be available, be sure careful studying for right interpretation.

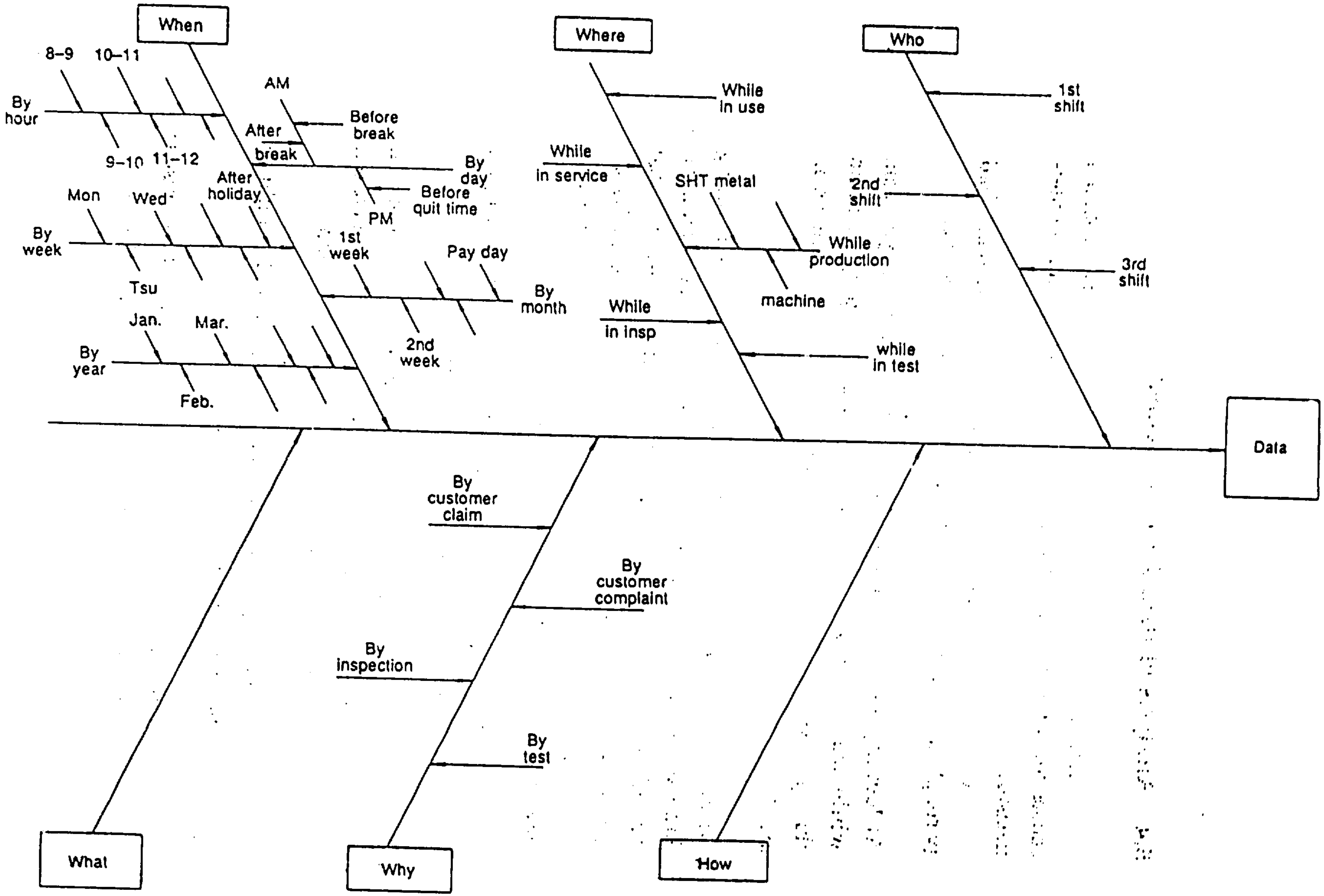


Fig. 6 Stratification of Data

5.4 Analysis of Data & Fact Obtained

Main objective for analysis is to identify any probable causes for solution and finally to isolate root-cause(s) for counter-measure(s).

In another words, to high-light where and what bad (wrong), and to clarify why they are bad (wrong) is its role.

A) Identify any possible probable causes as much as you can, while why dispersion is coming from are keeping in mind through 4M1E approach of fish-bone chart, that is as shown in fig. 7.

B) Some other causes beside 4M1E are also revealed during brainstorming session, as such customers using environment, boundary conditions, culture or, customs differences, etc., that any ideas are necessary to welcome and appreciate for analysis.

While identifying any probable dispersion causes, it is necessary to be careful for,

— Try to ask "Why dispersion be happened" 3–5 times, until probable cause(s) be identified.

— If you would take such as approaches "How to prevent dispersion", only brain-worked idea are popped out, not based on data analysis based on dispersion.

— To identify most affectable cause(s) which would directly influenc d to dispersion.

— Reversely, to identify and to eliminate negative cause(s) for Dispersion is also important for simplification.

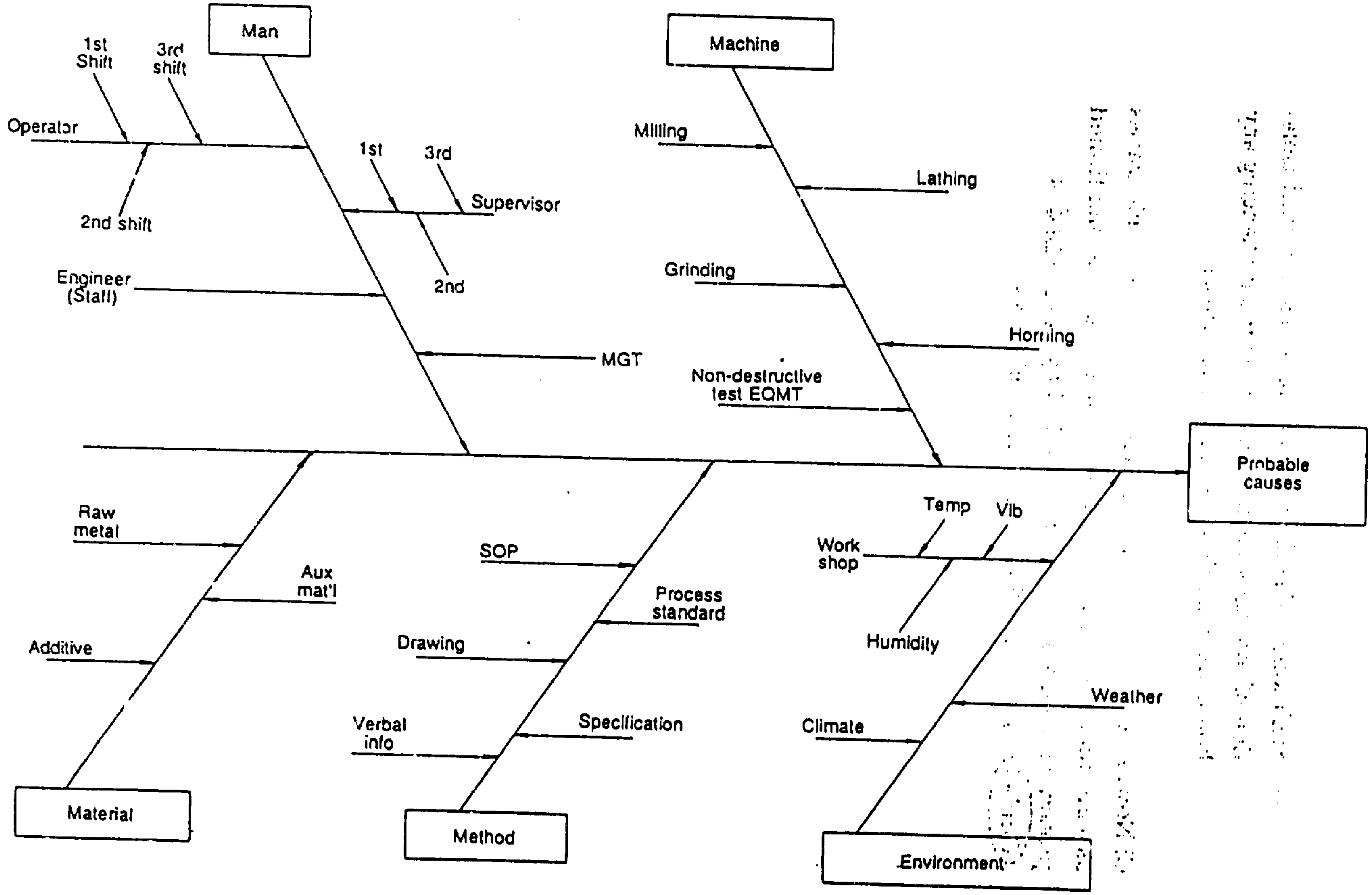


Fig. 7 Stratification of Cause Identification

— Such kinds of study must be continued on until isolation of root cause(s), is identified without changing any boundary conditions for dispersion causes.

C) Now, it is time to pick-up the-most affectable probable causes as candidates of root-causes through the above mentioned processings, such ones would be marked by underlined or Circled on the Fish-Bone Chart prepared before.

D) Isolate root-cause(s) among candidates of probable causes.

(1) To study and analyze past data or case-studying, and to identify which cause(s) mostly affect by studying 20~30 cases for justification.

(2) If any experimental test be avilable, its affects must be validated.

(3) If not possible, it must be validated by late action for effectiveness.

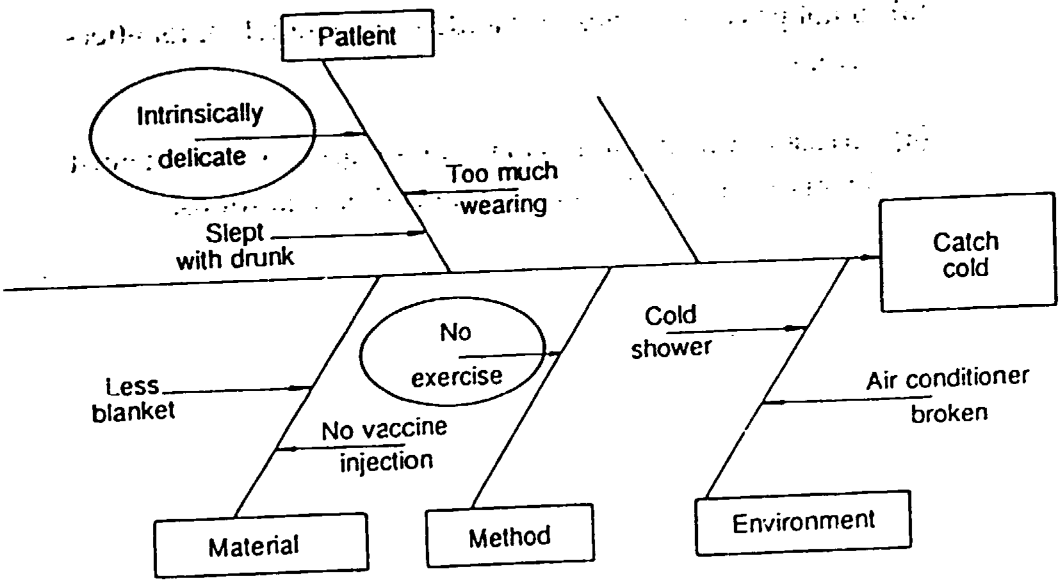
(4) In case any interaction is inevitable, experimental test must be performed without such interaction conditions.

5.5 Establishment of Counter-Measure(s)

(A) Establish counter-measure(s) for root-cause(s) isolated independently for

Remedial action — For result

Recurrent preventive action — For cause(s)



In case, the above case is analyzed as such,

Remedial action is	To take pill, to shot antibiotic injection, or to be in bed warmly
Recurrent preventive action is	To shot cold-preventive, and To health control practices

B) Deploy the same counter-measure to the population for improvement, which action is called as "Horizontal Deployment"

C) So far recurrent preventive action is taken for cause(s) to eliminate root-cause(s), its action might have side effect to other cause(s) as by-products – quality improved, but cost goes up high, and delivery date be late, or reversely cost reduced, but quality be degraded.

If such adverse effect is anticipated, it is better to apply the counter-measures partially and not all at same time, to confirm by-product.

D) Counter-measures established are necessary to notify and coordinate with any organizations related prior to full implementations.

5.6. Execution of Counter-Measures

A) Every counter-measure(s) are necessary to be understood by every subordinates related and must be explained and disseminated with their intention and expected effectiveness with how to implement.

B) Execute the counter-measures physically on project.

C) Record the action taken and the result obtained on formats specified.

5.7 Evaluation of Result Obtained

(A) Compare the result obtained with the data or graphication prepared at Step 2 as shown in Fig. 8.

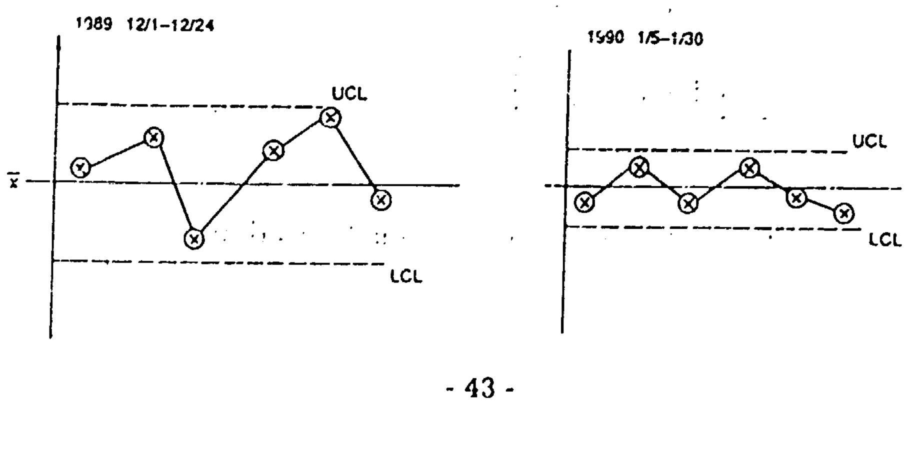
(B) Calculate the effectiveness for implemented counter-measures by monetarial value, through which every subordinates could be recognizable enough how much be contributed, and be motivated or challenged for future (next) project implementation.

(C) Evaluate if intended goal is physically achieved as planned, and also secondary achievement is necessary to identify for counter-measures' effectiveness, by quantitative direct indications.

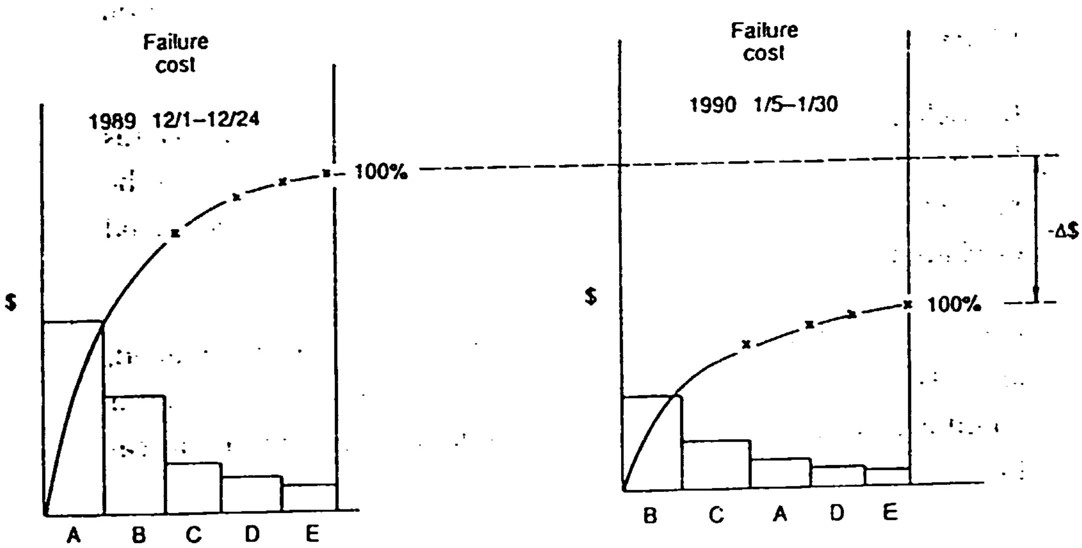
— When secondary achievement is remarkably evident, but primary one is low, the secondary is so much appreciated, and the primary tend to be neglected. This is most careful evaluation for why the primary one is not achieved as planned. But the secondary is effective. As for QC concept concerns, this could be evaluated as failure in planning and processing.

— When the results are not met with the goal, difference between result & goal is quite instructive information that in next project planning, the causes of such differences must be investigated to prevent from the same failure, as shown in Fig. 9.

By Control Chart



By Pareto



By Histogram

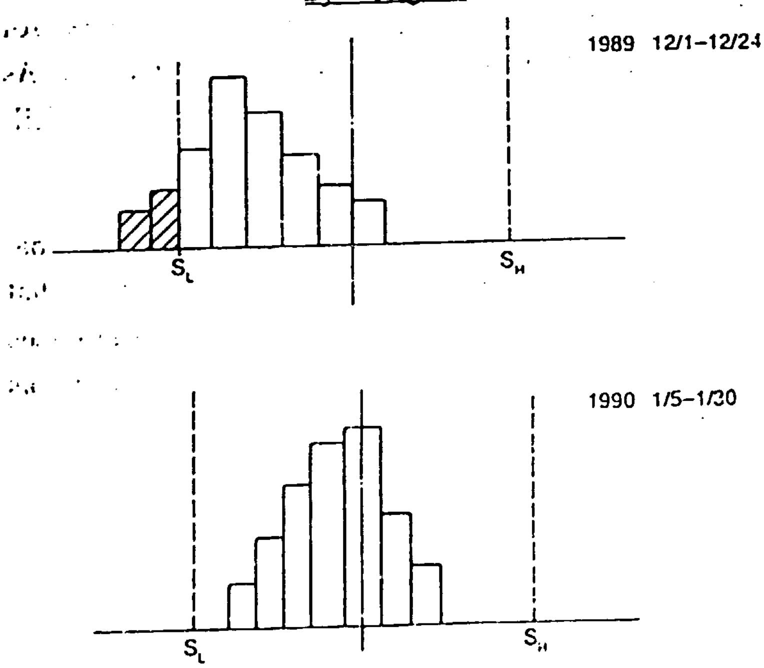


Fig. 8 Graphication of Status Indication

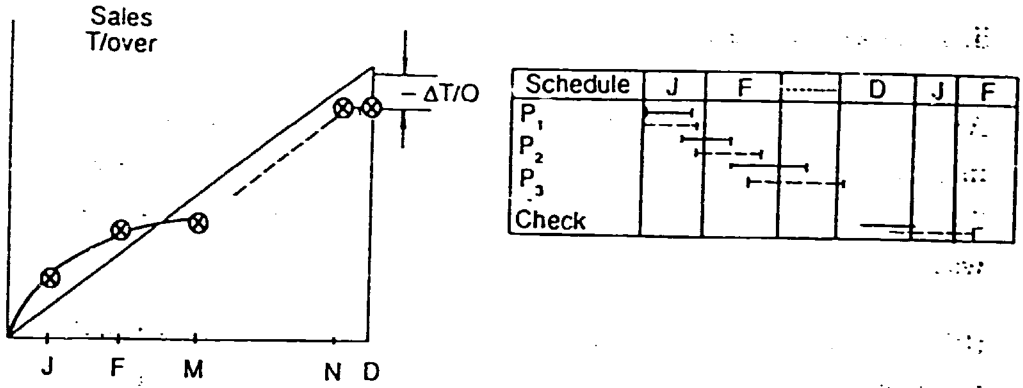


Fig. 9 Status Indication

D) As mentioned before, not only the secondary effectiveness, but some other qualitative, intangible or anticipated effectiveness are also necessary to mention at this stage,

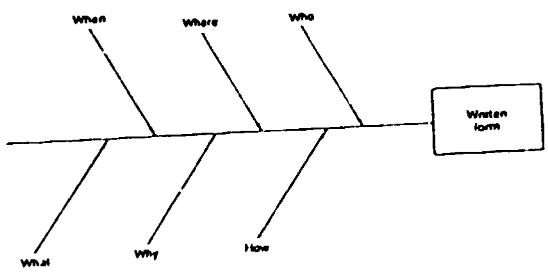
Qualitative effectiveness — Shorten time to take action, such as copying, tracing, etc.

Intangible effectiveness — Improve morale, improve empathy concept, etc.

5.8 Standardization

A): If project is not successfully achieved as planned, it could be interpreted as $\boxed{\text{Plan}}$ or $\boxed{\text{Do}}$ stages are something wrong that Step 2 to Step 7 are necessary to follow under QC story concept by way of "Way" concept.

(B) If project is achieved as planned, this counter-measure(s) must be standardized as a part of SOP (Standards Of Procedure) for implementing in daily routine-working area (Shops).
The counter-measures established are created by every technical expertises ideas and experiences into so popular and understandable procedures for other unskilled employees improvement in operation. To standardize, 5W1H approach are most recommendable for fault-less establishment of SOP by



Why	—	Why necessary such changes into SOP.
Who	—	Who have responsibility for implementing of SOP. for checking or evaluations.
When	—	When SOP will be implementing.
Where	—	Which processing shop will be implemented.
What	--	What kinds of action (Operation) are necessary to implement.
How	--	How to conduct such action into operation.

(C) These consideration are necessary to integrate into SOP as written form,

if SOPs have been established, these input are to be called, "Revision"

if SOPs are not established, this action can be called, "New"

if Have been SOPs are necessary to delete, can be called, "Rescind"

(D) Whenever standardization are conducted, their effective date for implementation are disseminated to every organization related.

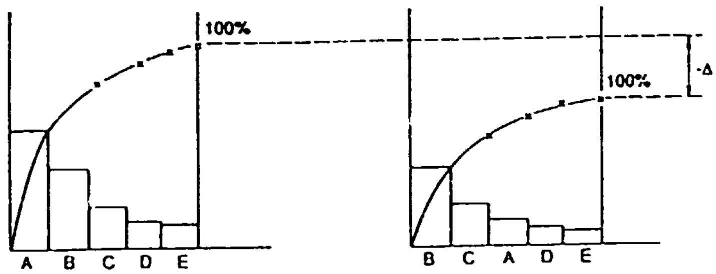
(E) After revised or new SOP are published, some kinds of education/Training program are necessary to install for full dissemination.

(F) After standardization, counter-measures established are necessary to consider if these are feasible enough to other similar operations for preventive actions.

(This is called as "Horizontal deployment", and is mandatory in TQC.)

5.9 Identification of Residual Problem and Future Program (Project)

(A)



Aforementioned example shows that "A" problem is now decreased but not zero yet, and "B" problem are now the worst situations.

(B). At this case, "A" problem is still going to correct until zero, and "B" is also to be zero are necessary to consider under "Vital Few" concept. "A" was a critical area to be solved, but after action, it has no critical today, nor "B" is the same.

(C) Usually, if the same project is continuing on sometime, people are tended to tire-of for such repetive action. Under such environment, it is recommendable to tackle another vital-few project at that time.

Also, residual area for "A" & "B" are better delegate to lower level people to tackle as their responsibilities for solution or wait and see their trend for some time.

(D) Established SOPs for improving project are necessary to conduct periodic check for their effectiveness are still existed.

(E) Overall self-examination for QC story processes of project is final action to be performed, as

- Project is exact vital-few, and valuable to tackle at this time.
- Project achievement processes are exactly following as scheduled.
- Project QC story are followed as planned.
- Analysis, root cause isolation and counter-measures are conducted by data appreciation concept.
- Project goal is fully accomplished as expected.
- No utilization for modified adjectives nor adverse for counter-measure establishment are fully implemented during whole QC story processings.
- How to establish for next project is always followed by after self-examination of the previous results.

10 2 '4

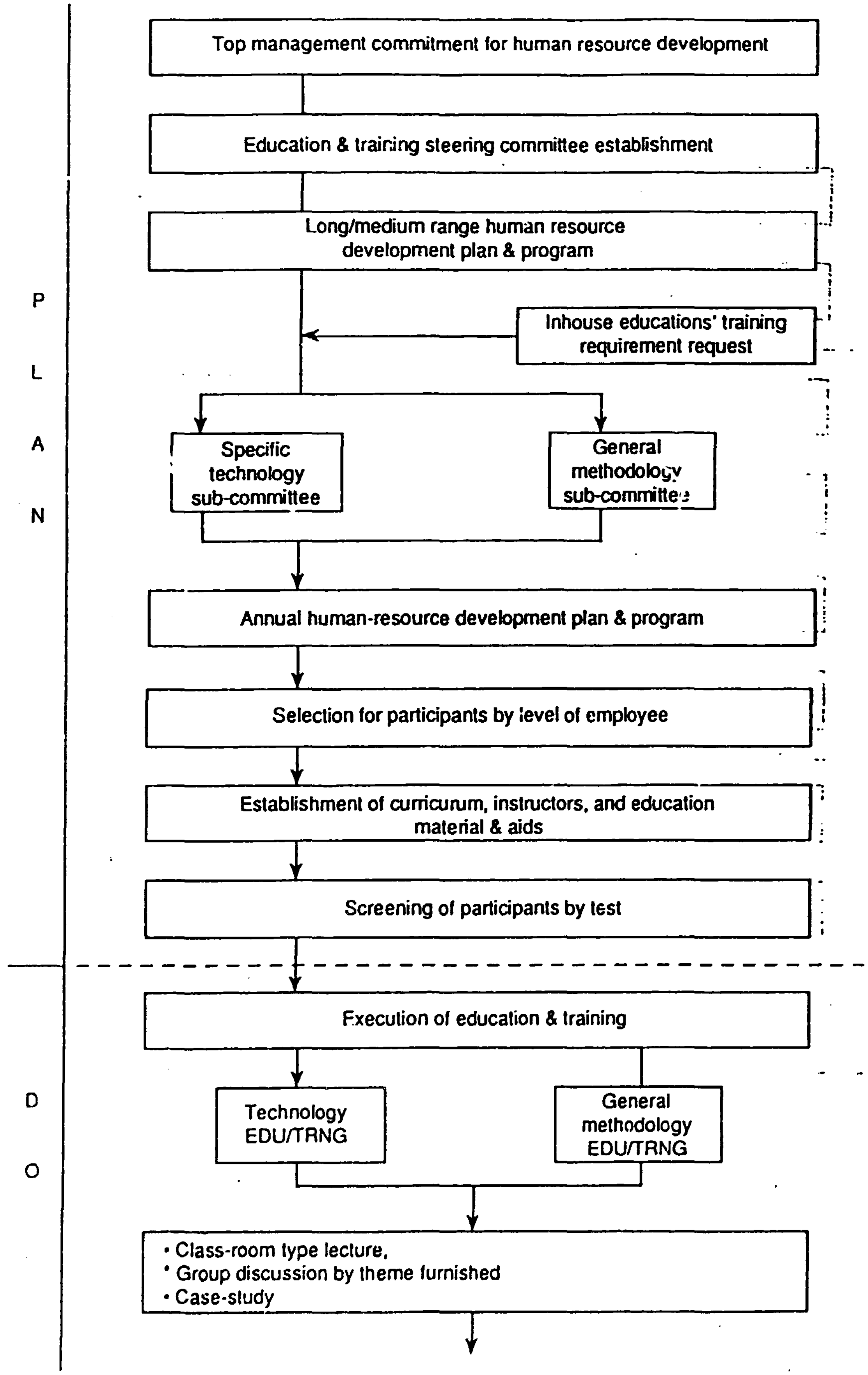
6. Education and Training

6.1 General

Employees education and training program are programmed by human-resources career development concept under top management's firm commitment which are explained in Fig. 10.

It's concept are necessary to be based on people-building as explained by old Chinese proverbs,

Bad farmer grows weeds
Good farmer grows rices
Better farmer cultivates rice-paddles
Best farmer builds human-beings.


P
L
A
N
D
O
Top management commitment for human resource development
Education & training steering committee establishment
Long/medium range human resource development plan & program
Inhouse educations' training requirement request
Specific technology sub-committee
General methodology sub-committee
Annual human-resource development plan & program
Selection for participants by level of employee
Establishment of curricurum, instructors, and education material & aids
Screening of participants by test
Execution of education & training
Technology EDU/TRNG
General methodology EDU/TRNG
• Class-room type lecture,
• Group discussion by theme furnished
• Case-study

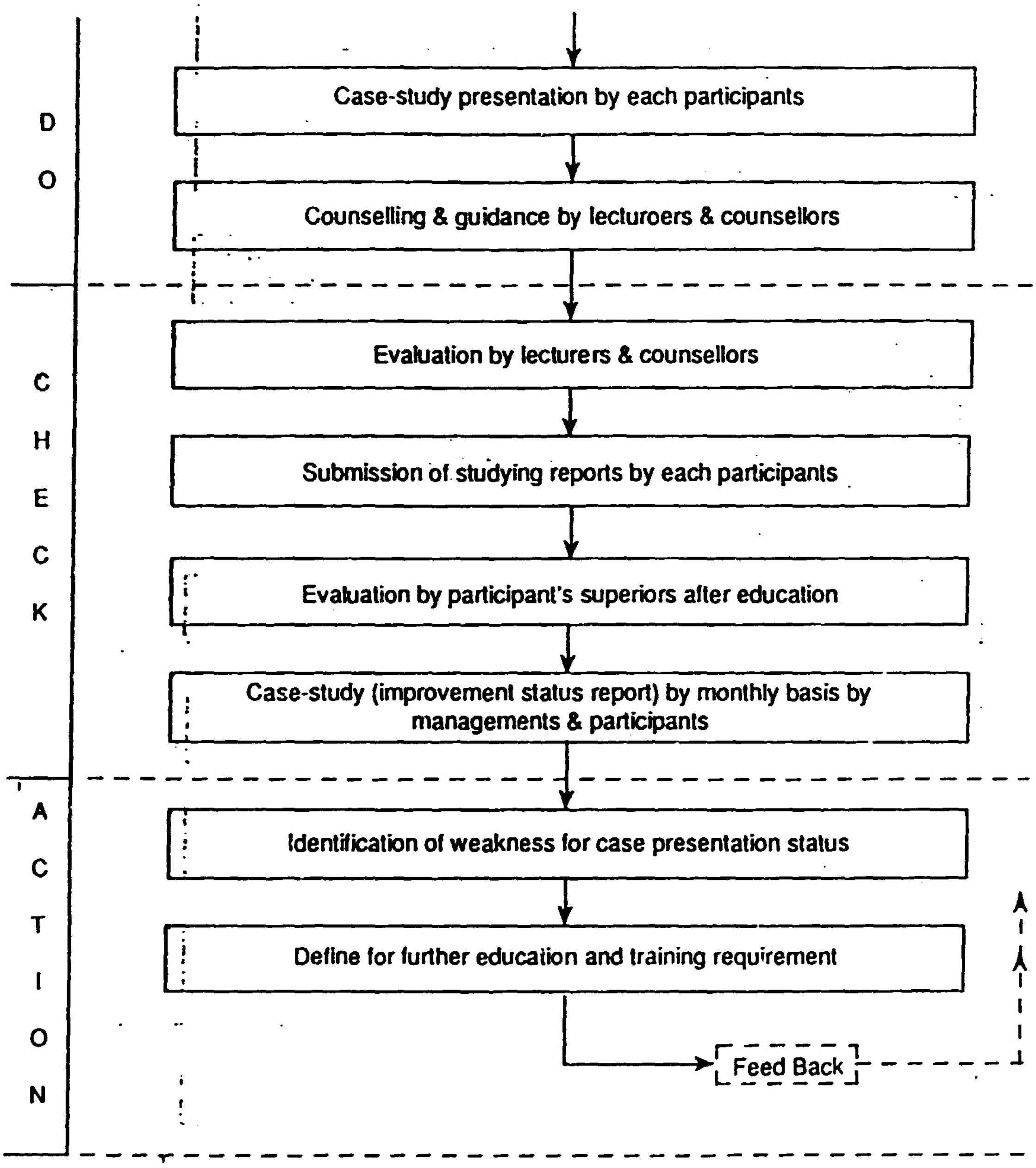


Fig. 10 Human Resources Education & Training Flow

Role of Education Office

1. **Establishment and Control of Company-Wide Human Resources Development System**

   (A) Understanding of Top Management Policy for Human Resources Development

   (B) Preparation of Human Resources Development System (Program & Plan)

   (C) Identification of Management & Supervisors Responsibility for their Subordinates Development

   (D) Organizing of Education System

   (E) Establishment of Education System Regulation and Standards

   (F) Estimation & Allocation of Educational Budget

   (G) Establishment of Long-& Medium Range Career Development Plan

   (H) Evaluation of job-Site Education Plans Established by Each Organizations and Follow-up

2. Identification of Education-Needs for Human Resources

(A) Identification of Education Needs or Weakness Based on Top Management Policy, Each Organizational Status & Weakness, and Technical & Technological Trends Analysis

(B) Prioritizing of the Above Finding depending on Criticality, Emergencyness and Inter-Organizations Analysis

(C) Decision of Physical Implementation Program

i) Participants Selection
ii) Instructor Selection
iii) Duration
iv) Budget
v) Goals

3. Supporting and Counselling of Site Management and Supervisors

(A) Furnishing of OJT-Processing Procedures Tools Methods to each Responsible Management & Supervisors

(B) Consultation of OJT Implementation to Improve their Effectiveness

(C) Furnishing of On-the Job Site Education Material

(D) Consultation of On-the Job Site Education Implements

4. Establishment & Implementation of Education Program

(A) Establishment of In-House Class-Room Type Education Program by Level, Skill, Technics, Technology & Organization

(B) Establishment of Participation Program Organized by Outside Facility

(C) Establishment of Long-& Medium Range Programs for the Aboves

(D) Implementation of the Aboves

5. Establishment Supporting and Expediting of Self Development Concept within Employees.

(A) Campaigning of the Necessity of Every Employees Self-Development Program (People Building)

(B) Encouraging every Employees be joining and Participating of People-Building Program

(C) Pursuading Every Employees be Recognizing of People-Building Program through Personal Contacts

(D) Evaluating of Status and Trends for Further Developments

6.2 Example of Curriculum by Levels

(A) Recommendable Curriculum for Top & Sr. Management

(1) Role of Top/Sr. management in quality control
(2) Understanding & appreciation of SQC
(3) Quality control in planning and design stages
(4) Quality control in production stage
(5) Quality control in marketing and service stages
(6) Quality assurance
(7) QC circle activity concept
(8) World-wide status of QC concept implementation

(B) Recommendable Curriculum for Middle Management

(1) Relationship between business management & SC
(2) General concepts of quality control
(3) Organization and management of QC
(4) Quality assurance (at development, production, market, service, and QA system)
(5) Implementation, promotion & education of QC
(6) Execution of quality control
(7) Relationship between QC & reliability
(8) Supplier control
(9) Role of middle management for QC circle activity
(10) Statistical method orientation

(C) Recommendable Curriculum for Staff & Engineers

(1) Orientation of quality control concept
(2) How to summarize data obtained
(3) Probability & statistics

(4) Statistical inspection & estimation for attributed & variable data
(5) Control chart
(6) Sampling inspection
(7) Variable analysis
(8) Regression analysis
(9) Design of experiments
(10) Sampling method
(11) Reliability engineering

(D) Recommendable Curriculum for Supervisory Employees

(1) Orientation of quality control
(2) Role of supervisors for quality control
(3) QC 7 tools orientation
(4) Improving and maintaining in workshop under "Control" concept
(5) Quality assurance
(6) Inspection
(7) QC circle concept

7. Facilitator's Role

7-1 DESIRABLE FACILITATOR

1) TO FAMILIARIZE QUALITY CONTROL CONCEPT AND METHODOLOGY.

2) TO HAVE ENOUGH CAPABILITY FOR EXPLAINING A PROBLEM BY QUANTITATIVE INDICATIONS. AND ANALYZING SUCH DATA BY A STATISTCAL METHOD.

3) TO FAMILIARIZE EVERY WORK-FLOW AND WORK-JOB IN EVERY WORK-SHOPS.

4) TO KNOW EVERY EMPLOYEES BY NAMES.

5) TO BE ACCEPTED AS A TRUSTWORTHY PERSONNEL.

6) TO HAVE GOOD HUMAN-RELATIONSHIP AMONG EVERY EMPLOYEES.

7) TO BE GOOD LISTNER.

8) TO HAVE ENOUGH CAPABILITY FOR PERSUASION

9) TO HAVE ENOUGH CAPABILITY FOR TEACHING SOME METHODOLOGY.

10) TO HAVE ENOUGH CAPABILITY FOR RIGHT DECISION.

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11) TO HAVE A PATIENT MANNER.

12) TO HAVE A SOUND AND STRONG BODY.

13) TO STAY AS A DUMMY GENERAL AT ALL TIMES.

14) TO RECOGNIZE HIMSELF, WHEN BEING SUCCESS, SUCH TQC ACHIEVEMENT ARE TO BE GIVEN AWAY TO THE RELATED PERSONNEL OR MANAGEMENT, IF NOT, SHARE THE REPONSIBILITIES WITH CONCERNED PERSONNEL.

15) TO RECOGNIZE HIMSELF AS A FACILITATOR IS NOTHING BUT A MEDICINE FOR SICK. IF IT IS EFFECTIVE, IT COULD BE APPRECIATED. IF NOT, JUST CASTING BY A COLD LOOK.

16) IF POSSIBLE, TO BE A EXPERT IN A SPECIFIC FIELD (TECHNOLOGY).

IT IS CERTAINLY IMPOSSIBLE TO LOCATE SUCH PERSONNEL, BUT FIND TQC MANIAC MAN AND EDUCATE THEM UNTIL HE CAN DEVELOP AND PROCRESS TO SUCH KINDS OF LEVEL UNDER LONG TERM PROJECT.

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7-2 SPECIFIC FUNCTION AS TQC FACILITATOR

1) IF QC--STORY ARE FULLY UNDERSTOOD AND IMPLEMENTED AT EVERY ACTIONS. BY EVERY EMPLOYEES.

2) IF IDENTIFIING OWN'S WEAKNESS AND STRONG AREA WITH QUANTITATIVE DAT/ AND ESTABLISHING SOME CORRECTIVE/ SUSTAINING ACTIONS FOR IMPROVING/ MAINTAINING OF SUCH STATUS.
   ----- IF YES. ENCOURAGE FOR CONTIN-UATION
   ----- IF NOT. IDENTIFY WHY NOT. AND SUPPORT AND WORK TOGETHER FOR CHALLENGING THEIR AWAR-NESS FOR CONTINUOUS IMPROVE-MENT CONCEPT.

3) IF MANAGEMET IS SELF-SATISFIED FOF ONLY FOLLOWING OWN BOSS'S ORDER. WITHOUT OWN VISION NOR STRATEGY.

4) EVEN IF ESTABLISHING OWN POLICY AND GOALS. BUT THEY ARE ALWAYS SET RATHER LOWER CONSERVATIVE WAYS. WITHOUT ANY HIGHLY SELF-MOTIVATED AMBITIOUS ONES.

5) IF ZERO-ACCIDENT OR ACCIDENT PRE-VENTION ACTIONS ARE ESTABLISHED AND IMPLEMENTED UNDER QC-STORY CONCEPT.

6) IF EVERY STANDARD OPERATIONAL PROCEDURE(sop) ARE ESTABLISHED FULLY IMPLEMENTANBLE AND CORRESPONDABLE WITH THE PRESENT PHYSICAL OPERATIONS BY OPERATORS.

----- FLOW-CHART
PROCEDURES — ARE AVAILABL
FORMAT

7) IF EVERY SOPs ARE ISSUED, STORED, REVISED, OR RESCINDED. AS SPECIFIED

8) IF EVERY MANAGEMENT ARE ESTABLISHED FOR SUBORDINATES MORALE MEASURING INDEXES AND IMPROVEMENT PROGRAMS.

9) IF EVERY MANAGEMENT ARE ESTABLISHED FOR WHITE-COLLOARS PRODUCTIVITY MEASUREMENT INDEXES AND THEIR IMPROVEMENT PROCEDURES.

10) IF EFFECTIVENESS OF QC TOOLS ARE EVALUATED.

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11) IF ANY REMARKABLE UTILIZATION CASE EXAMPLE OF QC METHOD ARE AVAILABLE IN TQC IMPLEMENTATION PROGRAM.

12) IF EVERY MANAGEMENT ARE PREVAILING FOR SELF-DEVELOPING PROGRAM UNDER THEIR OWN INITIATIVES WITH LONG TERM PROJECT.

13) HOW DEEPLY INVOLVE IN THEIR SUB-ORDINATES SELF-DEVELOPING PROGRAM AND SUPPORING BY EVERY MANAGEMENT.

14) IF EVERY MANAGEMENT ARE SUPPORTING FOR ESTABLISHMENT CF LIFE-WORK FOR EVERY SUBORDINATES.

15) IF EVERY SUBORDINATES' STATUS ARE WELL INFORMFD AND ANY NECESSARY ACTIONS ARE TAKEN PROPERLY.

16) IF ANY PROBLEMS RELATED WITH HUMAN RELATIONSHIP BETWEEN SUBORDINATED ARE OBERVED.

17) IF ANY CONFLICT ARE OBSERVED BE-TWEEN SAME LEVEL OF MANAGEMENTS DURING HORIZONTAL COOPERATION WORK

18) IF ANY DISCONTENT OR GRIEVANCE IN EMPLOYEES MINDS ARE COLLECTED BY MANAGEMENT TO PREVENT FROM FUTHER OUTBREAK.

19) IF ANY REPORTS ARE BUBMITTED WITH ENOUGH DATA EXPAINED REAL STATUS.

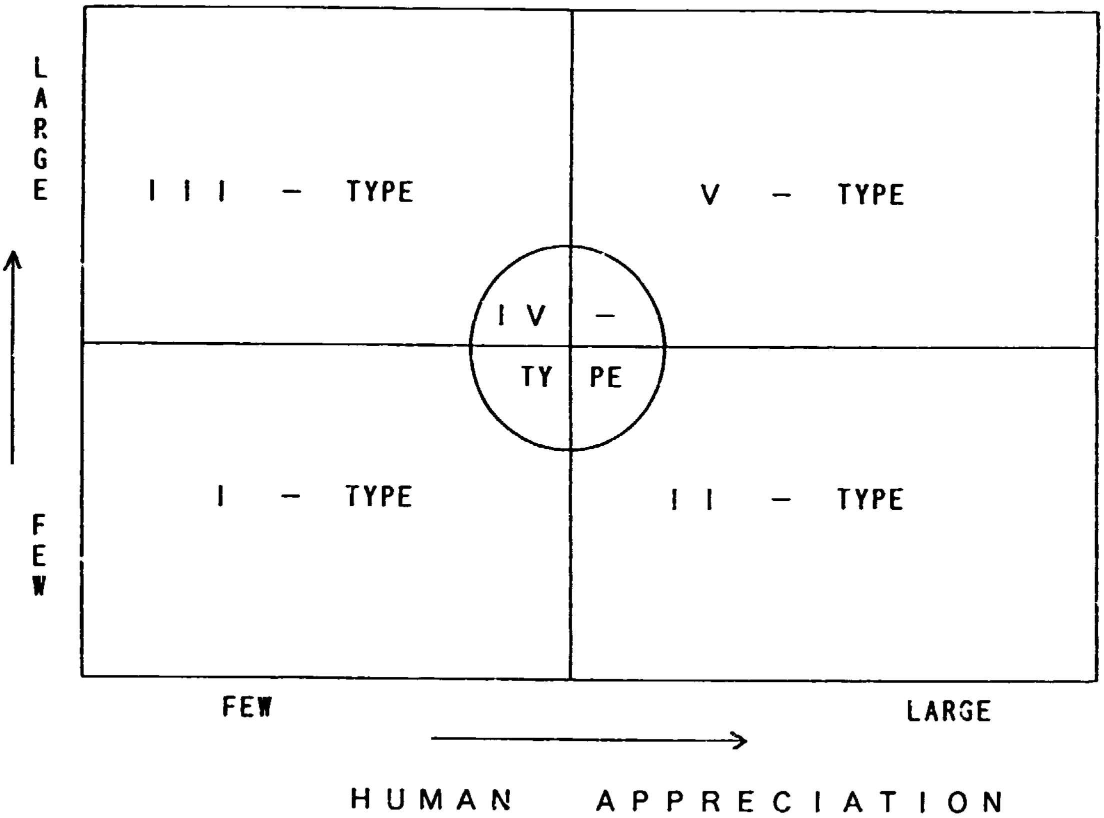
20) IF ANY CORRECTIVE ACTIONS ARE ESTABLISHED BY BOTH OF REMEDIAL AND RECURRENT PREVETIVE ACTIONS, AND FULLY AND PHYSICALLY IMPLEMENTED.

21) IF NOT GOOD REPORT BUT BAD NEWS REPORT IS SUBMITTED (PRODUCTION FAILURE. CUSTOMER CLAIM OR COMPLAINTS, OPERATOR ERROR, WARRANTY COMPENSATION, ETC) WITHOUT ANY DIFFICULTY.

22) IF EXPERIENCED WHEN SUBMITTED BAD NEWS REPORTS TO HIGHER MANATEMENT ANY EMBARRASSMENT HAS ENCOUNTERED.

23) IF EVER CHASING AND REQUESTING FO CORRECTIVE ACTIONS TO OTHER ORGANIZATION OR PERSONNEL, WHILE NOT BLAMING OWN'S RESPONSIBILITY.

8. DESIRABLE MANAGEMENT



I -TYPE MANAGEMENT

- -- LOW CONCERN FOR BOTH JOB AND SUBORDINATES
- -- ONLY PERFORM OR CONDUCT MINIMUM DUTY OR RESPONSIBILITY
- -- ALWAYS EVADE FROM CONFLICT, DIFFICULTY, FIGHT OR RESPONSIBILITY
- -- EVEN REQUESTED ANY OPINION OR IDEAS OR SUGGESTIONS, ALWAYS EXCUSE FOR CONSIDERATION AND MORE TIME, BUT NOTHING PRESENT
- -- DON'T WANT TO SEE HIS BOSS, ALWAYS HESITATE TO TALK
- -- ONLY SUBMIT REPORT REQUESTED

II -TYPE MANAGEMENT

-- LOW CONCERN FOR JOB, BUT HIGH FOR SUBORDINATES

-- PAY MORE ATTENTION FOR SUB-ORDINATES AS HUMAN-BEING, AND TRY TO COORPERATE WITH IN SHC BUT SO MUCH INTEREST FOR JOB ASSIGNMENT NOR ACHIEVEMENT

-- TRY TO EVADE CONFLICT, BLAME C DIFFICULTY UNLESS HIS SUBORDI NATES ARE INVOLVED

-- ALWAYS TAKE SUCH AS 'COME, COM DON'T HURRY TO CONCLUDE' TYPE SOLUTION

-- STAY WITH " YES-MAN ". WITH HI BOSS, AND NEVER SAY 'NO'

-- INFORM ANY PROBLEM TO HIS BOS

III -TYPE MANAGEMENT

-- HIGH CONCERN FOR JOB, BUT LOW FOR SUBORDINATES

-- WORK-FIRST TYPE MANAGEMENT

-- ALWAYS DRIVE SUBORDINATES HAF BY HIS OWN IDEA, AND NEVER CON SIDER THEIR PERSONAL NEEDS OF REQUEST

-- NEVER ACCEPT OTHER'S OPINION NOR IDEAS, BUT RATHER SUPPRESS AND TALK AWAY

-- SHOW HIS ACCOMPLISHMENT TO HI BOSS PROUDLY, AND TRY TO BE RECOGNIZED BY WITH BRAG

-- SOMETIMES, OPPOSE TO HIS BOSS

V -TYPE MANAGEMENT

-- NOT 'YES-MAN' NOR RESISTING PARTICULARLY.

-- ALWAYS LOOK AROUND WHICH WAY IS THE BEST FOR OWN'S SAKE

-- MOST OF TIME, " YSE, IT IS, BUT --- " TYPE OF EXPRESSION IS HIS APPROACH

-- ALWAYS STAY AT COMPROMISING ATTITUDE

-- MOSTLY, TAKE SEVERE ATTITUDE FOR FOLLOWING CO'S REGULATION

-- TRY TO COMPROMISE BETWEEN JOB RESPONSIBILITY AND HUMAN RE-LATIONSHIP

-- MEDIUM CONCERN FOR BOTH JOB & SUBORDINATES

V -TYPE MANAGEMENT

-- HIGHEST CONCERN FOR BOTH JOB & SUBORDINATES

-- DELEGATE SUBORDINATES FOR SOME SPECIFIC PLANNING, SCHDULING AND IMPLEMENTING AND MONITOR-ING, IF FOUND SOMETHING WRONG, ACTIVELY SUPPORTING AND COUN-SELLING FOR HIS SOLUTION TO BE DONE BY SUBORDINATE HIMSELF

-- NOT BE DIRECTOR, NOR CONDUCTOR, BUT STAY AT ADVISOR OR BIG-BROTHER OR SISTER SITUATION

-- WHEN OPINION OR IDEAS AR' NOT CONSENTABLE WITH HIS BOS., DE-BATE OR DISCUSS BY SYSTEMATIC AND SCIENTIFIC WAYS FOR RIGHT DECISION FRANKLY

(8)

Design of Experiments and Analyses

by Yasutoshi Washio

Contents

Chapter 1 What is design of experiments?

The present article describes the design of experiments. Let us elementary explain how to interpret the design of experiments.

§ 1.1 Introduction

In order to investigate the relationship between product characteristic values and manufacturing conditions, experiments are always carried out at shops or laboratories. More generally, experiments are performed as means of objectively grasping the cause and effect relation or as means of testifying the theories or hypotheses.

When proceeding to such experiments, there are a lot of factors to take up and there will arise problems as to which way to take or how to remedy errors inherent to experemental data. To answer these requirements, the discipline called a design of experiements has been developed. It is intended for giving solutions to:

(1) How to carry out the experiment in order that the given object will be attained most effecively. Namely, how to obtain as much correct information as possible with a minimum number of assays.

(2) How to analyze data in order to deduct correct conclusions from experimental data which contain errors.

§ 1.2 Single factor experiment and factorial experiment

Suppose an experiment is performed for enhancing the strength of a product produced by a certain chemical process. Considered as important manufacturing conditions affecting the strength are reaction temperature and catalyst quantity. Let us find out their optimum conditions. (See Fig. 1.1.)

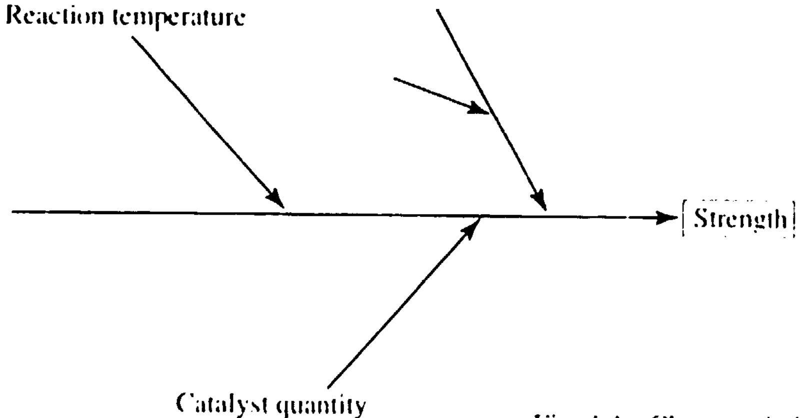


Fig. 1.1 Characteristics diagram

The qaulity characteristics to pursue such as the strength are evaluated in terms of characteristics value and the manufacturing conditions subjected to the experiment are referred to as factors, which are generally expressed in upper case letters A, B, C, ... Here, the reaction temperature is expressed as A, and the catalyst quantity as B. To seek optimum conditions of each factor, an experimental will be performed. For example, suppose an experiment will be executed with reaction temperature (A) changed to 3 stages: 400°C, 500°C and 500°C. At this time, 400°C, 450°C and 500°C are levels of factor A and are expressed as A_1, A_2 and A_3, respectively.

Suppose 2 factors A and B are technically studied and that their levels are set to:

A (reaction temperature): A_1(400°C), A_2(450°C), A_3(500°C)
B (catalyst qauntity): B_1(3%), B_2(4%)

The experimental way often practiuced insuch a case before the design of experiments appeared is as follows. Firstly, with a view to determining an optimum level of factor A, the level of B is fixed, for example, at B_1, experiments are carried out with A changed to A_1, A_2 and A_3 and, from the results, the optimum level of A is decided. Suppose it is A_2. Then, in order to determine an optimum level of factor B, A is fixed at the just determined optimum level A_2, B only is changed to B_1 and B_2 for experiment and, from the results, the optimum level of B is decided. Suppose it is B_2. Then, A_2B_2 is rated as the optimum operating conditions of the chemical process. This is the illustration.

Such an experimental method is referred to as a single factor experiment since, at a time, only one factor is taken up.

When the single factor experiment is applied to several factors which are interactive on each other, it may lead to an erroneous conclusion and is not a good solution.

The effect of a factor level may depend on what is the level of another factor. It means that a certain combination of several may cause a particular effect. In this case, they are deemed interactive and the effect is referred to as an interaction. From a different viewpoint, the fact that there exists an interaction between factors means that their effect is not cumulative.

Let us explain the interaction referring to examples. Suppose, in the above example, the "true" strength in each level combination of A and B is as shown in Fig. 1.2. As A is sucessisvely changed to A_1, A_2 and A_3 when B is at B_1, the strength increases to 5 and 10 successively. This relationship holds true also when B is at B_2. Therefore, the level effect of A remains unchaged regardless of whether B is at B_1 or B_2, whereby there is no interaction between A and B. (Now, the level effect was examined with B fixed). The conclusion remains the same by examining the level effect of B with A fixed.) Fig. 1.2 can graphically be illustrated as in Fig. 1.3. When there is no interaction, the graph has parallel lines.

A \ B	B_1	B_2
A_1	30	40
A_2	35	45
A_3	45	55

Fig. 1.2 True strength (when there is no interaction)

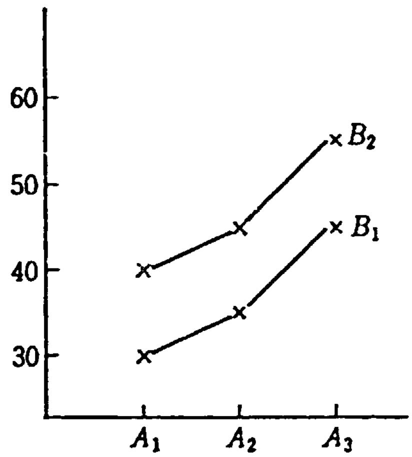


Fig. 1.3 When there is no interaction

On the other hand, let us suppose this time that the "true" strength at each level combination of A and B is as given by Fig. 1.4. When B is at B_1, changing A to A_1, A_2 and A_3 successively raises the strength to 5 and 10 accordingly but, when B is at B_2, this relationship does not hold. In this case, therefore, an interaction exists between A and B. Fig. 1.4 an graphically expressed as in Fig. 1.5. When there is an interaction, curves are not parallel with each other.

A \ B	B_1	B_2
A_1	30	40
A_2	35	55
A_3	45	35

Fig. 1.4. True strength (when there exists an interaction)

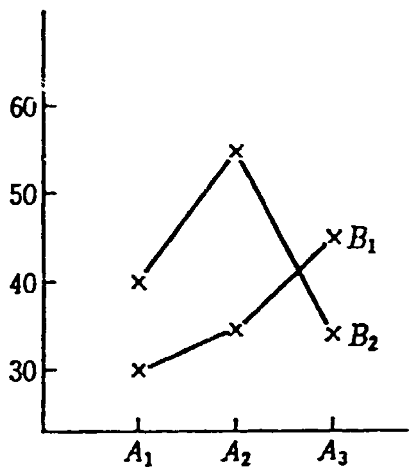


Fig. 1.5 When there exists an interaction

The interaction between 2 factors is referred to as 2-factors interaction, that between 3 as 3-factor interfaction, and so on. For interaction, symbol "x" is used. For example, the interaction between 2 factors A and B is expressed by A and B. Existence of an interaction is theoretically and empirically recognized and is a known fact at present.

As against the interaction, an averaging effect of factor level is referred to as a main effect. The main effect and interactive effect are generically referred to as a factorial effect.

Let us resume the first example and suppose that the true strength at each level combination of A and B is as given in Fig. 1.4 for when there exists an interaction. Let us carry out a single factor experment here. By fixing B to B_1 and changing the level of A, we will obtain A_3 as an optimum level of A. Then, by fixing A to A_3 and changing the level of B, we will obtain B_1 as an optimum level of B. In short, we will obtain A_3B_1 as a optimum level combination. However, a veriFig. optimum level combination is A_2B_2. As is clear from this simple example, a wrong conclusion may be obtained is the single factor experiment is applied when there is an interaction between factors. (In this present case, a truly optimum level combination A_2B_2 will be obtained if B is fixed to B2 first for determining the optimum level of A.)

The experimental method devised to remedy such a weak point of the single factor experiment is the factororial experiment, where all factors in question are retained at a time and are combined in every possible way. This solution evaluates all factor effects exhaustively, thereby giving a correct conclusion.

Let us explain this fact referring to a simplest experiment involving 2 factors A and B each having 2 levels. With the single factor experiment, where the optimum level of A is located upon fixing B to any level and then the optimum level of B is located upon fixing A to thus located optimum level, the obtained data is as given in Fig. 1.6. on the other hand, with the factorial experiment where all level combinations are tested, the obtained data is as given in Fig. 1.7. In case of Fig. 1.6., the effect of A (when changed to A_1 to A_2) is known only for the case where B is at B_1 and not for the case where B is at B_2. Therefore, interaction A x B cannot be evaluated. In case of Fig. 1. 7, however, the effect of A can be known when B is at each of B_1 and $B_2$and, from the difference between the 2 cases, interaction A x B can be evaluated.

Fig. 1.6
Single factor experiment

A \ B	B_1	B_2
A_1	O	O
A_2	O	×

Fig. 1.7
Factorial experiment

A \ B	B_1	B_2
A_1	O	O
A_2	O	O

o: Data exists x: No data exists in Fig.s 1.6 and 1.7

Note: Practically, experimental data involves errors. To separate them from true interactive results, there must be more than one experimental data per cell.

If, then, factors are known non-interactive, does the single factor experiment suffice dispensing with factorial experiment or other new processes? The answer is in the negative. In this case also, resorting to a factorial experiment is advantageous from the viewpoint of the assay count and accuracy of obtained information. (See example problem 1.1.) There is another experimental method of obtaining necessary information with less assay count unlike the factorial experiment. (See example problem 1.2.)

Other points advocated for the factorial experiment are that the applicable range of conclusion is wide and that the conclusion has a universality on account of the fact that, when examining effects of a factor. levels of other factors are changed in different ways. '

Example problem 1.1
Suppose 2 factors A (2 levels) and B (2 levels) have no interaction A x B. Single factor experiment and factorial experiment give their data as given in Fig.s 1.8 and 1.9. The assay count is 3 for the single factor experiment and 4 for the factorial experiment. Let us compare obtained information quantity .

For the single factor experiment, the effect of A is estimated by x_{21} - x_{11} and that of B by x_{12} - x_{11}. For the factorial experiment, on the other hand, the effect of A can be estimated by any of y_{21} - y_{11} and y_{22} - y_{12}, thereby allowing to evaluate the effect of A in 2 different ways. The same goes for B, giving 2 evaluations y_{12} - y_{11} and y_{22} - y_{21}. In short, the factorial experiment is double

the single factor experiment in terms of the obtained information quantity. If the single factor experiment is to obtain as much information quantity as the factorial experiment of 4
assays, the single factor experiment must be recommenced, involving 2 x 2 = 6 assays.

Fig. 1.8
Single factor experimental data

A \ B	B_1	B_2
A_1	x_{11}	x_{12}
A_2	x_{21}	×

Fig. 1.9
Factorial experimental data

A \ B	B_1	B_2
A_1	y_{11}	y_{12}
A_2	y_{21}	y_{22}

This fact reveals that, even when there is no interaction, the factorial experiment is advantageous from the viewpoint of assay count also.

§1.3 Fractional factorial design and orthogonal array

Increasing the number of factors increases the number of their level combinations, which is translated into many total assays for the factoria. experiment. If each of 10 factors has 2 levels, for example, there will be $2_{10}=1024$ combinations or assays to carry out. There arises a problem
that so many assays could not be performed as a matter of fact.

2 standpoints are evoked for this problem.

(I) So many assays cannot be executed from the viewpoint of time and cost and must be lessened, where possible.
(2) There is no objection to increased number of assays but securing uniform experimental environments is difficult or performing all assays under homogeneous conditions is practically impossible .

Fractional factorial design technique is reserved to cope with case (1), and confounding technique to cope with case (2). Case (2) mainly involves agricultural experiments. Therefore, the fractional factorial design technique will be discussed in this article.

The reason why, in the factorial experiment, all level combinations must be tested is to consider the existence of interaction between factors. If 10 factors of 2 levels each are retained, the factorial experiment imposes 1024 assays to evaluate all of the main effect of all factors plus 1013 interactions broken down into:

2-factor interactions as per $\binom{10}{2}$ = 45
3-factor interactions as per $\binom{10}{3}$ = 120
4-factor interactions as per $\binom{10}{4}$ = 210
5-factor interactions as per $\binom{10}{5}$ = 252
6-factor interactions as per $\binom{10}{6}$ = 210
7-factor interactions as per $\binom{10}{7}$ = 120
8-factor interactions as per $\binom{10}{8}$ = 45
9-factor interactions as per $\binom{10}{9}$ = 10
10-factor interactions as per $\binom{10}{10}$ = 1

From the technical point of view, interactions deemed existing are up to 2-factor or at most 3-factor order and 3-factor or higher interactions may not exist as a matter of fact. If so, it is not necessary to experiment all level combinations but only a part of them.

The following example shows that. when there is not interaction. comparisons between levels are available without having to experiment all factor level combinations.

Example problem 1. 2

Suppose 3 factors A, B and C of 3 levels each do not interact among 2 nor 3 factors. Here, let us proceed to the following experiment which is neither single factor experiment nor factorial experiment. Select a Latin square out of 3 x 3 as shown in Fig. 1.10. 3 x 3 Latin squares refer to an array where 3 numbers 1, 2 and 3 are repeated in columns and rows in such an order that each occurs only once in any column or row. As shown in Fig. 1.11, allocate the columns to levels of factor A and the rows to levels of factor B and the squares to levels of factor C.

Fig. 1.10
3 x 3 Latin square array

1	2	3
2	3	1
3	1	2

Fig. 1.11
Arrangement of factors according to Latin square array

	B_1	B_2	B_3
A_1	C_1	C_2	C_3
A_2	C_2	C_3	C_1
A_3	C_3	C_1	C_2

Experiment 9 level combinations obtained by the above.
(Readers who already know the orthogonal array will readily perceive that it is Taguchi's orthogonal aray L9(3_4) where rows 1. 2 and 3 are allocated to factors A, B and C.)

No.1 $A_1B_1C_1$	No.4 $A_2B_1C_2$	No.7 $A_3B_1C_3$
No.2 $A_1B_2C_2$	No.5 $A_2B_2C_3$	No.8 $A_3B_2C_1$
No.3 $A_1B_3C_3$	No.6 $A_2B_3C_1$	No.9 $A_3B_3C_2$

Such an experiment allows the experiment performed with A1 to include each of factor B levels B_1. B_2 and B_3 and C levels C_1, C_2 and C_3 only once. This nature holds true also for experiments performed with A_2 or A_3. Therefore. the sums of 3 data tested with each of A_1, A_2 and A_3 are equally affected by factors B and C. Therefore, comparing these sums allows to compare the effects of A's levels.

The same goes perfectly with B. Namely. comparing the sums of data obtained with each of B_1. B_2 and B_3 allows to estimate B's level effects. The same goes also with C.

If a factorial experiment is to be performed. all of $3^3 = 27$ level combinations would have to be tested. Please note that. by resorting to the above Latin square array, only 9 special level combinations are tested out of the above.

Suppose a single factor experiment has been perfonned on
the assumption that there exist no interaction. If you are contented with a minimum number of assays. 7 assays suffice to compare A, B and C's level effects. When their accuracy is compared, the assays resorting to Latin square array is 3 times better. Therefore, we can safely say that 9 assays of design of experiments scheduls process are equivalent to 21 assays of single factor experiment.

The approach of the fractional factorial design is reducing the number of assays on the supposition that a part of interactions do not exist as in example problem 1.2 and not unconditionally. This supposition is practically feasible without any inconvenience. Therefore. the number of
assays is decreased skillfully upon making use of technical knowledge without losing anything particular for it.

The approach of confounding technique is dividing the experiment under the condition of giving up to obtain a part of unimportant information of interactions.

Actual experiments involve a tremendous number of factors and impose use of fractional factorial design or confounding. Before utilizing these techniques, fairly difficult theories would have to be learned. However. with the aid of an orthogdnal array developed by Gen-ichi TAGUCHI, et al., the fractional factorial design or confounding can easily be designed. In Japan, designing the experiments with orthogonal array is widely practiced.

§1.4 Experimental sequence randomization and experimental site management

Suppose 3 levels A_1, A_2 and A_3 are selected for factor A and are compared with each other. If each level is to be repeated 4 times, totally 12 assays will have to be periormed. Then how to proceed to them?

Conventionally, the experimental sequence was not particularly taken into account and, for example, A_1 would have been tested 4 times successively, then A_2 4 times and then A_3 4 times. Even if, as a result, A_2 and A_3 gave good results, and A_1 no good results, it might have possibly been attribuFig. to the fact that the operator was not yet familiarized with the first assay of A_1. It means that the experimental sequence effect and A's level effect are confounded and indiscernible. The inability of discriminating 2 factorial effects from each other is expressed as confounding by the design of experiments scheduls.

To eliminate such confounding, the design of experiments in a random order. It is referred to as a randomization of the experimental sequence. Its approach is as follows.

When carrying out totally 12 assays, experimental (environmental) conditions other than factor A must completely be identical. However well the experimental site may be controlled, creating completely the same site is impossible and the environmental conditions will have to be
deemed different from one assay to another. Therefore, given : .

(Share of influence by difference in environmental conditions over 1st assay results) $= \varepsilon_1$

(2nd) $= \varepsilon_2$

.....

(12th) $= \varepsilon_{12}$

$\varepsilon_1, \varepsilon_2, \ldots, \varepsilon_{12}$ will be different in quantity. The (ε_i) is referred to as an experimental error. The approach of randomization of experimental sequence is to subject all assays of A_1, A_2 and A_3 equitably to the influence by experimental error upon admitting that experimental errors
differ from each other.

The intervention of randomization for experimental sequence turns experimental errors incidental to each experimental data into random variables and allows to apply statistics to experimental data analyses.

On the other hand. it is also necessary to actively manage the experimental site so as to minimize the experimental errors. If. in the said example. the environmental conditions are regarded excessively varying.
the site is divided into 4 blocks from the viewpoint that the environmental conditions are the same within each of. but not among. the blocks. A_1, A_2 and A_3 are tested at random in each block. This technique is called a randomized block design (See Chapter 5). The random technique. on the other hand. is called a completely randomized design.

§ 1.5 Experimental data analyses and statistical process

Suppose that. in order to determine an optimum level of reaction temperature (A), 3 levels A_1. A_2 and A_3 are selected. that they are tested 5 times each and that product strength data is obtained as given in Fig. 1.12 (greater data is deemed better). Conventionally. means at each level would have simply been compared and A_2 would have been rated the best. followed by A_1 and then A_3.

Fig. 1.12 Experimental data

Level	A_1	A_2	A_3
Repeat	65	66	62
	66	65	59
	65	72	65
	59	69	63
	63	70	61
Mean	63.6	68.4	62.0

The way of concluding is problematic because. even if there is no difference at all between levels of V. respective data which are different on account of experimental errors would give means different among A_1. A_2 and A_3. Thus. it is not allowed to come to a hasty conclusion that there be differences among A_1. A_2 and A_3 simply because means differ from each other but judge whether the difference in mean among A_1. A_2 and A_3 is significant or can be absorbed in experimental errors.

An elementary approach to it is to plot respective data as given in Fig. 1. 13. If we observe Fig. 1.13, we will find that A_2 is good and that there is no difference between A_1 and A_3. If we see Fig. 1.14, we will find no difference among A_1, A_2 and A_3.

Experimental errors intervene in experimental data inevitably and this face must be taken into account before reaching a conclusion. For this purpose, we have only resort to a statistical technique -- testing of hypothesis and estimation .

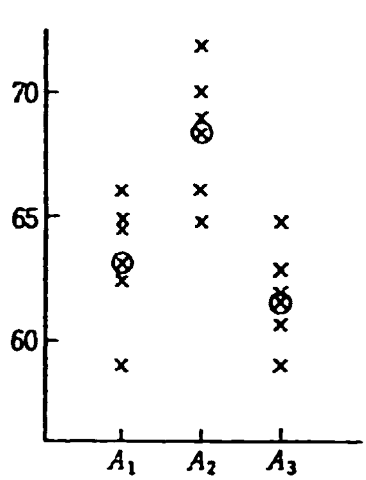


Fig. 1.13
Plotting respective data

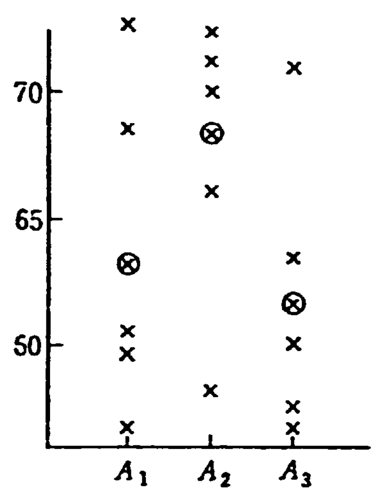


Fig. 1.14
Plotting respective data

In the present case. let us proceed to testing upon assuming that there is no difference between levels of A. If this hypothesis is rejected, judge that there is a difference between levels of A and, otherwise, judge that there is no significant difference. If the testing has led you to judge that there is a difference between levels of A. proceed to check which is the optimum level of A by way of estimating the effects of each level of A.

Chapter 2
Design of one dimension

Here will be described the way and analyses of data of basic experiment for a single factor. Most concepts for analyzing the experimental data appear in this chapter. Therefore, this chapter constitutes the basis of subsequent chapters and will give details particularly.

§2. 1 What is design of one dimension?

An experiment where only one factor (A) is retained and its "a" levels $A_1, A_2, \ldots, A_a$ are selected and compared with each other is called 1-factor experiment. More generally, it is recommended to think that "a" different methods or conditions — or processings — are given rather than regarding $A_1, A_2, \ldots, A_a$ as levels of factor A.

If each level is repeated n times, totally '*an*' assays will be performed. An experiment where all '*an*' assays in a random sequence is referred to as having a design of one dimension. In this case, all variations of the experimental site other than of factor A will be regarded as experimental errors .

The design of one dimension where all "*an*" assays re-performed in a random sequence may be said to conespond to 1-factor experiment executed by completely randomized design.

Here, the number of repetition is n for all levels but it may be different from one level to another. We will give you precautions for when the number of repetition differs by levels in §2.6.

Example problem 2 . 1
In order to increase the production quantity for a certain chemical product, an optimum catalyst has to be found out. For catalyst, 4 levels or A_1 (cunent), A_2, A_3 and A_4 have been selected. The number of repetition for each level has been set to 5. It has been determined to carry out to tally 20 assays in a random sequence, which has been decided by a Fig. of random numbers as given in Fig. 2.1.
4 assays can be repeated a day, thus requiring 5 days of experimental period .

Upon measuring the production quantity for each assay, data has been obtained as given in Fig. 2.2. Analyze the data and give a conclusion.

Fig. 2.1 Experimental sequence by design of one dimension

Sequence	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Level	A_1	A_2	A_3	A_1	A_3	A_2	A_2	A_3	A_3	A_1	A_4	A_1	A_4	A_3	A_2	A_2	A_4	A_1	A_4	A_4
	1st day				2nd day				3rd day				4th day				5th day			

Fig. 2.2 Production quantity (kg/h)

Level	A_1	A_2	A_3	A_4
Repeat	138	141	147	140
	144	147	141	132
	139	139	148	136
	140	143	145	139
	135	146	150	133

The experimental data by design of one dimension can generally be expressed by x_{ij}, where subscript i refers to level of A, and j to repetition order. I. e., x_{ij} denotes jth data of level A i. The experimental data can generally be tabulated as in Fig. 2.3.

Fig. 2.3 Data of design of one dimension

Level	A_1	A_2	$\cdots$	A_i	$\cdots$	A_a
Repeat	x_{11}	x_{21}	$\cdots$	x_{i1}	$\cdots$	x_{a1}
	x_{12}	x_{22}	$\cdots$	x_{i2}	$\cdots$	x_{a2}
	$\vdots$	$\vdots$		$\vdots$		$\vdots$
	x_{1n}	x_{2n}	$\cdots$	x_{in}	$\cdots$	x_{an}
Sum	$x_{1\cdot}$	$x_{2\cdot}$	$\cdots$	$x_{i\cdot}$	$\cdots$	$x_{a\cdot}$
Mean	$\bar{x}_{1\cdot}$	$\bar{x}_{2\cdot}$	$\cdots$	$\bar{x}_{i\cdot}$	$\cdots$	$\bar{x}_{a\cdot}$

Use the following symbols. (See Note.)

$$x_{i\cdot} = \sum_{j=1}^{n} x_{ij} = \text{[sum of data at level A}i\text{]}$$

$$\bar{x}_{i\cdot} = \frac{1}{n} x_{i\cdot} = \frac{1}{n} \sum_{j=1}^{n} x_{ij} = \text{[mean of data at level A}i\text{]}$$

$$x_{\cdot\cdot} = \sum_{i=1}^{a} \sum_{j=1}^{n} x_{ij} = \text{[sum of all data]}$$

$$\bar{x}_{\cdot\cdot} = \frac{1}{an} x_{\cdot\cdot} = \frac{1}{an} \sum_{i=1}^{a} \sum_{j=1}^{n} x_{ij} = \text{[mean of all data]}$$

Note: Rules of symbols. A subscript with a dot "." means that a sum is calculated for the subscript. A letter with a bar (-) put above means that a sum is calculated at the dot of subscript and then averaging is made.

§2.2 Data model

Before proceeding to a data analysis, set a data model based on the way of experiment, etc. Firstly, an approach:

$$x_{ij} = \mu_i + \varepsilon_{ij} \qquad (2.1)$$

where ,

μ_i : Population mean at level A i (true characteristic value)
ε_{ij} : Experimental error in data x_{ij}

may be appropriate. Values μ_i and ε_{ij} are naturally unknown.
Resolve μ_i into:

$$\mu_i = \bar{\mu}_{\cdot} + (\mu_i - \bar{\mu}_{\cdot})$$

$$= \mu + \alpha_i \qquad (2.2)$$

where,

$$\bar{\mu}_{\cdot} = \frac{1}{a} \sum_{i=1}^{a} \mu_i, \qquad \mu = \bar{\mu}_{\cdot}, \qquad \alpha_i = \mu_i - \bar{\mu}_{\cdot}$$

μ which is the mean of μ_1, μ_2, ... μ_a is called a **general mean**.
α_i which is an off-position of μ_i from μ, is called an effect of level A_i (or main effect of A). From the definition of α_i, $\sum_{i=1}^{a} \alpha_i = 0$

As a model, equation (2. 1) suffices but, for the design of experiments, is not used as it is but upon resolving μ_i into [general mean + effect of level A_i] as given in equation (2.2).

Then, error ε_{ij} can be regarded as a realized value of vaiable (random variable) by randomization of experimental sequence. Error ε_{ij} is supposed to be a variable which follows normal distribution N (0, σ^2) of mean 0 and variance σ^2 independently from each other — to be represented by symbol "NID (0, σ^2)." The symbol NID stands for Normally Independently Distributed. The assumption means that errors $\varepsilon_{11}, \varepsilon_{12}, \ldots, \varepsilon_{an}$ in each experitnental data are regarded as random samples of size an hom N (0, σ^2). Therefore, σ^2 constitutes a criterion of expressing the experimental error size and is called an **error variance**.

From the above, set as a data model:

$$\chi_{ij} = \mu + \alpha_i + \varepsilon_{ij} \qquad (2.3)$$

where,

μ : General mean

α_i : Effect of level A_i; $\sum_i^a \alpha_i = 0$

ε_{ij} : Error (variable); NID (0, σ^2)

The data model is a mathematical prerequisite in testing of hypothesis or estimation to be performed hereafter.

Problems and approaches

What we want to know is (1) whether or not there are differences among levels $A_1, A_2, \ldots, A_a$ and (2), if yes, which is good. Let us try to solve this problem based on model equation (2.3). Since the effect of level A_i is set at α_i, problem (1) may be asking whether or not there are differences among $\alpha_1, \alpha_2, \ldots, \alpha_a$ and problem (2) may be asking which if yes, is the greatest.

The statistical approach to poblem (1) is to test the hypothesis that there are no differences between levels of A or that all of $\alpha_1, \alpha_2, \ldots, \alpha_a$ are equal :

$$H_0: \alpha_1 = \alpha_2 = \ldots = \alpha_a = 0$$

If, by this testing, hypothesis H_0 is rejected, judge that there are differences among levels $A_1, A_2, \ldots, A_a$ or, if not, judge that there are not significant difference among levels $A_1, A_2, \ldots, A_a$.

The statistical method for problem (2) is to estimate level effects $\alpha_1, \alpha_2, \ldots, \alpha_a$

§ 2.3 Analysis of variance

Testing of hypothesis that there are not differences among levels of A— referred to as testing of A — is conducted by **analysis of variance** to be explained hereaffer.

Generally, when there are data $x_1, x_2, \ldots, x_n$ their variance is measured as the sum of squares of deviation of each data (x_i) from the total mean ($\bar{x}.$) or:

$$\sum_{i=1}^{n}(x_i-\bar{x}.)^2 \qquad (2.4)$$

This approach is often resorted to hereafter. Equation (2.4) is called a **sum of squares.**

The analysis of variance starts with resolving total sum of squares which consists in resolving the all data variance by factors which give a.variance to data.

Resolving total sum of squares

In the present case, the variance of all experimental data is given by:

$$\sum_{i=1}^{a}\sum_{j=1}^{n}(x_{ij}-\bar{x}..)^2 \qquad (2.5)$$

It is called an **total sum of squares** and is expressed by S_T.

2 factors are conceivable as factors of giving a variance to data: The fact that the experiment is performed with "a" levels $A_1, A_2, \ldots, A_a$ and the fact that there are experimental errors. (See data model equation (2.3).) Therefore, total sum of squares S_T is resolved by tbe 2 fectors. As a result, the total sum of square is resolved as follows.

$$\underbrace{\sum_{i=1}^{a}\sum_{j=1}^{n}(x_{ij}-\bar{x}..)^2}_{\text{Total sum of squares (ST)}} = \underbrace{n\sum_{i=1}^{a}(\bar{x}_{i}.-\bar{x}..)^2}_{\text{Sum of squares of differences within A (SA)}} + \underbrace{\sum_{i=1}^{a}\sum_{j=1}^{n}(x_{ij}-\bar{x}_{i}.)^2}_{\text{Error sum of squares } (S_e)} \qquad (2.6)$$

Let us explain equation (2.6). Let us examine the 1st term of right side.

$$n\sum_{i=1}^{a}(\bar{x}_{i\cdot}-\bar{x}_{\cdot\cdot})^2 \qquad (2.7)$$

If multiplier n is eliminated, the equation is a sum of squares of deviations of $\bar{x}_{1\cdot}, \bar{x}_{2\cdot}, \ldots, \bar{x}_{a\cdot}$ from their mean $\bar{x}_{\cdot\cdot}$ and, therefore, expresses a variance among $\bar{x}_{1\cdot}, \bar{x}_{2\cdot}, \ldots, \bar{x}_{a\cdot}$ and, thus, may be considered as a sum of squares which expresses the difference between levels of factor A. From this fact, equation (2. 7) gives a **sum of squares of differences between levels of A**, which is represented by symbol S_A.

Then, examine the 2nd term of right side: .

$$\sum_{i=1}^{a}\sum_{j=1}^{n}(x_{ij}-\bar{x}_{i\cdot})^2 \qquad (2.8)$$

$\sum_{j=1}^{n}(x_{ij}-\bar{x}_{i\cdot})^2$ is a sum of squares of deviations between $x_{i1}, x_{i2}, \ldots, x_{in}$ and their mean $\bar{x}_i$ and expresses variances among $x_{i1}, x_{i2}, \ldots, x_{in}$. Since $x_{i1}, x_{i2}, \ldots, x_{in}$ are n experimental data at A_i level, variances between them are solely attribuFig. to experimental errors. Since equation (2.8) totals a sum of squares attribuFig. to the experimental errors for "a" levels of A, it still expresses a variance attribuFig. to the experimental errors and may be considered as a sum of squares expressing the experimental error quantity. From this fact, equation (2. 8) is said to give an error sum of squares (or sum of squares of residuals), which is indicated by S_e.

Proof of equality: Firstly, resolvihg will be made as:

$$x_{ij} - \bar{x}_{\cdot\cdot} = (\bar{x}_{i\cdot} - \bar{x}_{\cdot\cdot}) + (x_{ij} - \bar{x}_{i\cdot})$$

Squaring both sides gives:

$$(x_{ij} - \bar{x}_{\cdot\cdot})^2 = (\bar{x}_{i\cdot} - \bar{x}_{\cdot\cdot})^2 + (x_{ij} - \bar{x}_{i\cdot})^2 + 2(\bar{x}_{i\cdot} - \bar{x}_{\cdot\cdot})(x_{ij} - \bar{x}_{i\cdot})$$

Here, let us obtain a sum $\sum_{i=1}^{a}\sum_{j=1}^{n}$ for i and j on both sides.

Thus, the left side will have total sum of squares S_T. On the other hand, each term of the right side will be:

$$\sum_{i=1}^{a}\sum_{j=1}^{n}(\bar{x}_{i\cdot}-\bar{x}_{\cdot\cdot})^2 = n\sum_{i=1}^{a}(\bar{x}_{i\cdot}-\bar{x}_{\cdot\cdot})^2 \longrightarrow S_A$$

$$\sum_{i=1}^{a}\sum_{j=1}^{n}(x_{ij}-\bar{x}_{i\cdot})^2 \longrightarrow S_e$$

$$2\sum_{i=1}^{a}\sum_{j=1}^{n}(\bar{x}_{i\cdot}-\bar{x}_{\cdot\cdot})(x_{ij}-\bar{x}_{i\cdot}) = 2\sum_{i=1}^{a}(\bar{x}_{i\cdot}-\bar{x}_{\cdot\cdot})\sum_{j=1}^{n}(x_{ij}-\bar{x}_{i\cdot})$$

$$= 2\sum_{i=1}^{a}(\bar{x}_{i\cdot}-\bar{x}_{\cdot\cdot})\underbrace{\left[\sum_{j=1}^{n}x_{ij}-n\bar{x}_{i\cdot}\right]}_{\parallel \atop 0} = 0$$

thus proving that equation (2.6) holds true. —

Note: Subscript T in symbol S_T stands for Total sum of squares, subscript A in symbol S_A stands for A in "sum of squares of differences within A" and subscript e in S_e stands for error in enor sum of squares. The reason why e only is not in a upper case letter is to reserve E for later use in S_E which means a sum of squares of differences within E in case factors A, B, C, D,E ... are discussed. —

Variance analyzing Fig.

Fig. 2.4 illustrates equation (2.6) for resolving the total sum of squares. Columns 1 and 2 are for resolving the total sum of squares. Meanings of other columns will successively explained hereafter.

Fig. 2.4 Variance analyzing Fig.

Variance factor	Sum of squares	Degree of freedom	Mean square	F_0	Expected mean sqaure
error	S_A	$a-1\ (=\phi_A)$	$\frac{S_A}{a-1}\ (=V_A)$	$\frac{V_A}{V_e}$	$\sigma^2+n\sigma_A^2$
withinA	S_e	$a(n-1)\ (=\phi_e)$	$\frac{S_e}{a(n-1)}\ (=V_e)$		σ^2
Total	S_T	$an-1\ (=\phi_T)$			

$\left(\text{Note: } \sigma_A^2=\frac{1}{a-1}\sum_{i=1}^{a}\alpha_i^2\right)$

Degree of freedom

The column of the degree of freedom in the variance analyzing Fig. indicates the degree of freedom of a factorial square distribution proved for sum of squares multiplied by a certain constant or under a certain condition. However, that degree of freedom has a fact of matching the number of independent components when considering that the sum of squares consists of a certain number of independent squares. Therefore, in reality, the degree of freedom for each sum of squares is obtained resorting to this fact.

Firstly, let us observe:

$$S_A = n\sum_{i=1}^{a}(\bar{x}_{i.} - \bar{x}_{..})^2$$

Apparently, it is a sum of squares for "a" components in:

$$(\bar{x}_{1.} - \bar{x}_{..}),\quad (\bar{x}_{2.} - \bar{x}_{..}),\quad (\bar{x}_{a.} - \bar{x}_{..})$$

However, each of these "a" components is a deviation from the mean, the sum will be zero. Therefore, the number of independent components is (a-1) and the degree of freedom for S_A is (a-1).

Then, examine:

$$S_e = \sum_{i=1}^{a}\sum_{j=1}^{n}(x_{ij} - \bar{x}_{i.})^2$$

Apparently, it is a sum of "an" components in:

$$\begin{array}{ccc}
(x_{11} - \bar{x}_{1.}) & (x_{21} - \bar{x}_{2.}) \ldots & (x_{a1} - \bar{x}_{a.}) \\
(x_{12} - \bar{x}_{1.}) & (x_{22} - \bar{x}_{2.}) \ldots & (x_{a2} - \bar{x}_{a.}) \\
\vdots & \vdots & \vdots \\
(x_{1n} - \bar{x}_{1.}) & (x_{2n} - \bar{x}_{2.}) \ldots & (x_{an} - \bar{x}_{a.})
\end{array}$$

But, the sum of n components on each row is zero and, therefore, the number of independent components is $a(n - 1)$.
Therefore, the degree of freedom of Se is $a(n - 1)$.

Finally, examine:

$$S_T = \sum_{i=1}^{a}\sum_{j=1}^{n}(x_{ij} - \bar{x}_{..})^2$$

Apparently, it is a sum of squares for " *an* " components in:

$$
\begin{array}{ccc}
(x_{11} - \bar{x}_{..}) & (x_{21} - \bar{x}_{..}) \ \ldots & (x_{a1} - \bar{x}_{..}) \\
(x_{12} - \bar{x}_{..}) & (x_{22} - \bar{x}_{..}) \ \ldots & (x_{a2} - \bar{x}_{..}) \\
\cdot & \cdot & \cdot \\
\cdot & \cdot & \cdot \\
\cdot & \cdot & \cdot \\
(x_{1n} - \bar{x}_{..}) & (x_{2n} - \bar{x}_{..}) \ \ldots & (x_{an} - \bar{x}_{..})
\end{array}
$$

Since the sum of all these components is zero, the number of independent components is $(an - 1)$. Therefore, the degree of freedom of S_T is $(an - 1)$.

The degree of freedom is represented by symbol ϕ. When the degree of freedom of S_T, S_A and S_e is expressed by ϕ_T, ϕ_A, and ϕ_e, respectively, an equality:

$$\phi_T = \phi_A + \phi_e \qquad (2.9)$$

holds corresponding to the resolving (equation (2.6)) of total sum of squares.

A more practical way of obtaining the degree of freedom will be learning by heart the rules:

Degree of freedom of total sum of squares: ϕ_T = (No. of all data) - 1

Degree of freedom of sum of squares of differences within A:
ϕ_A = (No. of levels of factor A) - 1

and obtaining the last degree of freedom ϕ_e by equation (2.9) as:

$$\phi_e = \phi_T - \phi_A$$

Mean square
The sum of squares divided through degree of freedom is called a mean square, which is represented by symbol V. The mean square among A is expressed by V_A and the mean square of errors is expressed by V_e.

Expected mean square
Mean squares V_A and V_e are calculated from experimental data (x_{ij}). On the other hand, experimental data (x_{ij}) differs from one experiment to another on account of errors even if the experiment is identical. Therefore, values of V_A and V_e change at every experiment.

According to statistical term, V_A and V_e are statistics. Let us calculate the expected values .

$$E\{V_A\} = \sigma^2 + n\sigma_A^2 \qquad (2.10)$$
$$E\{V_e\} = \sigma^2$$

where
$$\sigma_A^2 = \frac{1}{a-1}\sum_{i=1}^{a}\alpha_i^2$$

(See §2.7 for these calculations.) The column of expected mean square in the variance analyzing Fig. is substituted with this result.

Equation (2.10) reveals that. V_e is unbiased estimator for error variance σ^2, and V_A that for $\sigma^2 + n\sigma^2_A$.

Note: In this articlel, the expected value of variable x is expressed as $E\{x\}$, and the variance of x as $V\{x\}$. —

Testing

Hypothesis Ho to test is that there is no difference between levels of A and is expressed by H_0: $\alpha_1 = \alpha_2 = ... = \alpha_a = 0$ but, using σ^2_A defined as an expected mean square, also by H_0: $\sigma^2_A = 0$.

Let us observe the column of expected mean square in the variance analyzing Fig. in Fig. 2.4. $E\{V_e\} = \sigma^2$ indicates that Ve is a mean of σ^2 and $E\{V_A\} = \sigma^2 + n\sigma^2$ indicates that V_A is a mean of $\sigma^2 + n\sigma^2_A$. Therefore, the mean of V_A will be greater than the mean of V_e. If H_0 is correct, since $\sigma^2_A = 0$, V_A and V_e would have the same mean. Therefore, the ratio V_A/V_e calculated would be near if H_0 is correct or V_A/V_e would be greater than 1 if H_0 is not correct. From this fact, we will intuitively hint upon a testing method:

$\frac{V_A}{V_e}$ is nearly 1 $\Rightarrow$ H_0 is not rejected

$\frac{V_A}{V_e}$ is far greater than 1 $\Rightarrow$ H_0 is rejected

Then, how great V_A/V_e must be in order that Ho is rejectod?
To determine its limit value, statistical theory becomes necessary .

The theory indicates that V_A/V_e follows F distribution of degree of freedom (ϕ_A, ϕ_e) if Ho is conect. Therefore, given significant level a for testing, we have only to judge that:

$$\frac{V_A}{V_e} > F(\phi_A, \phi_e; \alpha), \text{ Ho is rejected}$$
$$\frac{V_A}{V_e} \leqq F(\phi_A, \phi_e; \alpha), \text{ Ho is not rejected} \qquad (2.11)$$

The article uses a symbol in Fig. 2.5 as F distribution point. Namely, F (ϕ_1, ϕ_2;p) is plotted so that the area located on the right of F distribution for degree of freedom (ϕ_1, ϕ_2) will be P or where the probability of being greater than that value is P in F distribution of degree of freedom (¢1, ¢2).

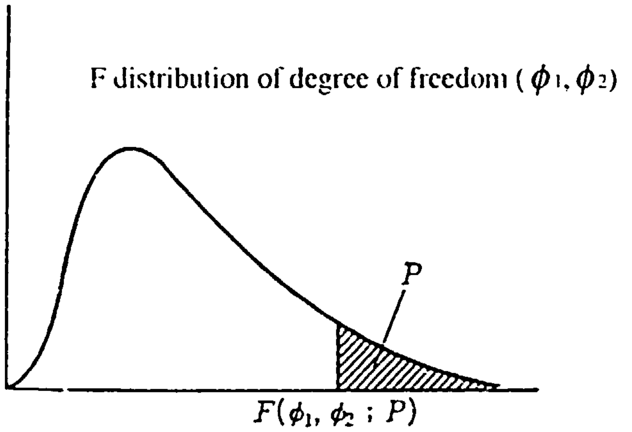


Fig. 2.5 Percent point for F distribution

For significant level a for testing, 5% or $\alpha = 0.05$ is usually selected. When the hypothesis is rejected in testing with significant level of 5%, a term "5% significant" is used. In case of 5% significant, whether significant level of 1% is still significant or not may be examined.

The column of F_0 in the variance analyzing Fig. is prepared for calculating the ratio V_A/V_e so as to facilitate the testing.

§2.4 Calculation of sum of squares

What is troublesome in creating a variance analyzing Fig. is calculating a sum of squares. When calculating a sum of squares, pay attention generally to the following.

(1) When manually calculating it by Fig. top calculator or the like, subject the data to a linear transformation to change it into simple values and calculate the sum of squares for the changed values. Then, return it to a sum of squares for the initial data. I.e., convert the initial data $\{x_{ij}\}$ into simple values $\{u_{ij}\}$ by:

$$u_{ij} = (x_{ij} - g) \times h \qquad (2.12)$$

and calculate the sum of squares for $\{u_{ij}\}$.

Given that the sum of squares for converted value $\{u_{ij}\}$ is S'_T, S'_A and S'_e, the sum of squares S_T, S_A and S_e for initial data $\{x_{ij}\}$ is obtained by:

$$S_T = \frac{1}{h^2}S'_T, \qquad S_A = \frac{1}{h^2}S'_A, \qquad S_e = \frac{1}{h^2}S'_e \qquad (2.\ 13)$$

Therefore, for calculation of sum of squares, subtracting (adding) a certain value from (or to) the data does not change the sum of squares.
(2) When calculating a sum of squares, do not use the defining equation (2.6) as it is for sum of squares but deform it so as to facilitate the calculation.

For calculating S_T, S_A and S_e, use of the following equations is recommendod

$$S_T = \sum_{i=1}^{a} \sum_{j=1}^{n} x_{ij}^2 - \frac{x_{..}^2}{an}$$

$$= \text{(sum ot squares of individual data)} - \frac{\text{(sum of all data)}^2}{\text{No. of all data}}$$

$$S_A = \sum_{i=1}^{a} \frac{x_{i.}^2}{n} - \frac{x_{..}^2}{an}$$

$$= \frac{\text{(Sum of data at level } A_1)}{\text{No. of data at level } A_1} + \frac{\text{(Sum of data at level } A_2)}{\text{No. of data at level } A_2} + \cdots$$

$$+ \frac{\text{(Sum of data at level } A_a)^2}{\text{No. of data at level } A_a} - \frac{\text{(Sum of all data)}^2}{\text{No. of all data}}$$

$$S_e = S_T - S_A$$

Here,

$$\frac{x_{..}^2}{an} = \frac{\text{(Sum of all data)}^2}{\text{No. of all data}}$$

appears always in calculating a sum of squares and is called a **correction term** and expressed by CT.

Notes 1. Proof of equation (2.13)
From equation (2.12).

$$x_{ij} = g+\frac{1}{h}u_{ij}$$

$$\bar{x}_{i\cdot} = \frac{1}{n}\sum_{j=1}^{n}x_{ij} = \frac{1}{n}\sum_{j=1}^{n}\left(g+\frac{1}{h}u_{ij}\right) = g+\frac{1}{h}\bar{u}_{i\cdot}$$

$$\bar{x}_{\cdot\cdot} = \frac{1}{an}\sum_{i=1}^{a}\sum_{j=1}^{n}x_{ij} = \frac{1}{an}\sum_{i=1}^{a}\sum_{j=1}^{n}\left(g+\frac{1}{h}u_{ij}\right) = g+\frac{1}{h}\bar{u}_{\cdot\cdot}$$

Therefore,

$$S_T = \sum_{i=1}^{a}\sum_{j=1}^{n}(x_{ij}-\bar{x}_{\cdot\cdot})^2 = \sum_{i}^{a}\sum_{j}^{n}\left[\frac{1}{h}(u_{ij}-\bar{u}_{\cdot\cdot})\right]^2$$

$$= \frac{1}{h^2}\sum_{i}^{a}\sum_{j}^{n}(u_{ij}-\bar{u}_{\cdot\cdot})^2 = \frac{1}{h^2}S'_T$$

Other equdities are proven likewise.
Notes 2. Proof of equation (2. 14)

$$S_T = \sum_{i=1}^{a}\sum_{j=1}^{n}(x_{ij}-\bar{x}_{\cdot\cdot})^2 = \sum_{i}^{a}\sum_{j}^{n}(x_{ij}^2-2\bar{x}_{\cdot\cdot}x_{ij}+\bar{x}_{\cdot\cdot}^2)$$

$$= \sum_{i}^{a}\sum_{j}^{n}x_{ij}^2-2\bar{x}_{\cdot\cdot}\underbrace{\sum_{i}^{a}\sum_{j}^{n}x_{ij}}_{\substack{\parallel \\ an\bar{x}_{\cdot\cdot}}}+an\bar{x}_{\cdot\cdot}^2 = \sum_{i}^{a}\sum_{j}^{n}x_{ij}^2-an\bar{x}_{\cdot\cdot}^2$$

$$= \sum_{i}^{a}\sum_{j}^{n}x_{ij}^2-\frac{x_{\cdot\cdot}^2}{an}$$

$$S_A = n\sum_{i=1}^{a}(\bar{x}_{i\cdot}-\bar{x}_{\cdot\cdot})^2 = n\sum_{i=1}^{a}(\bar{x}_{i\cdot}^2-2\bar{x}_{\cdot\cdot}\bar{x}_{i\cdot}+\bar{x}_{\cdot\cdot}^2)$$

$$= n\sum_{i=1}^{a}\bar{x}_{i\cdot}^2-2n\bar{x}_{\cdot\cdot}\underbrace{\sum_{i}^{a}\bar{x}_{i\cdot}}_{\substack{\parallel \\ a\bar{x}_{\cdot\cdot}}}+na\bar{x}_{\cdot\cdot}^2$$

$$= n\sum_{i=1}^{a}\left(\frac{x_{i\cdot}}{n}\right)^2-an\bar{x}_{\cdot\cdot}^2 = \sum_{i=1}^{a}\frac{x_{i\cdot}^2}{n}-\frac{x_{\cdot\cdot}^2}{an}$$

Calculation example

Let us proceed to a variance analysis for example problem 2. 1. Subject the data x_{ij} to a linear transformation :

$$u_{ij} = x_{ij} - 140$$

to turn it into simple value uij and create Fig. 2.6.

Fig. 2.6 Converted values

	A_1	A_2	A_3	A_4	
u_{ij}	-2	1	7	0	
	4	7	1	-8	
	-1	-1	8	-4	
	0	3	5	-1	
	-5	6	10	-7	
$u_{i\cdot}$	-4	16	31	-20	$23(=u_{\cdot\cdot})$

From calculating formula for sum of squares (2.14), correction term CT' for converted value $\{u_{ij}\}$ and sums of squares S'_T, S'_A and S'_e are

$$CT' = \frac{(23)^2}{4\times 5} = 26.45$$

$$S'_T = (-2)^2+(4)^2+\cdots+(-7)^2-26.45 = 484.55$$

$$S'_A = \frac{(-4)^2+(16)^2+(31)^2+(-20)^2}{5}-26.45 = 300.15$$

$$S'_e = S'_T-S'_A = 484.55-300.15 = 184.40$$

From equation (2.13), sums of squares S_T, S_A and S_e for initial data $\{x_{ij}\}$ are,

$$S_T = S'_T, \quad S_A = S'_A, \quad S_e = S'_e$$

Thus, the variance analyzing Fig. in Fig. 2. 7 is obtained.

Since F_0 or 8.68 is greater than F(3, 16; 0.05) = 3.24, the hypothesis that there be no difference within A is rejected by testing with significant level of 5%. Also, since F(3, 16; 0.01) = 5.29, it is significant at testing with significant level of 1%. Therefore, we may conclude that there is a definite difference between levels of A or that the production quantity is sure to differ according to A_1, A_2, A_3 and A_4.

Fig. 2.7 Variance analyzing Fig. for example problem 2.1

Variation factor	Sum of squares	Degree of freedom	Mean sqaure	Fo
Catalyst (A)	300.15	3	100.05	8.68**
Erroe (e)	184.40	16	11.53	
Total	484.55	19		

(* indicates 5% significant and ** indicates 1% significant)

Note: For an experimental data analysis, experimental errors are deemed homoscedastic. It is indicated, in case of design of one dimension, by the assumption that ε_{ij} conforms to N (0, σ^2) independently from each other in data model equation (2.3). The method of roughly checking the homoscedasticity of errors is use of a control limit in R control chart for controlling the dispersion in a group.

Let us check the homoscedasticity for data in example problem 2.1 . The data range at each level is $R_1 = 9$, $R_2 = 8$, $R_3 = 9$ and $R_4 = 8$ and, therefore, $\overline{R} =(9 + 8 + 9 + 8)/4 = 8.5$; for $n = 5$, $D_4 = 2.115$ and, therefore, $D_4\overline{R} = 18.0$. R_i is never above 18.0 and, therefore, that may be regarded as hom. cedastic. —

§2.5 Determination of optimum level

When it is judged that there is a significant difference within A, determine an optimum level upon estimating the effect at each level of A. The effect of level A_i is al. Since the levels are relatively compared, it is allowed to compare $\mu + \alpha_i$ upon adding certain valne μ: (general mean). In the article, the levels will be cempared in this fom with each other. In the present case, $\mu + \alpha_i$ is a population mean at level A_i (in Chapter 3 where cases with 2 or more factors are discussed, the level effct plus population mean is referred to as a population mean of that level).

For population means $\mu + \alpha_i$ at level A_i, the estimated point value is given by :

$$\hat{\mu}(A_i) = \overline{x}_i = \text{(mean of data at level } A_i) \qquad (2.15)$$

and the confidence interval having 95% of coefficient is given by:

$$\overline{x}_{i\cdot} \pm t(\phi_e, 0.05)\sqrt{\frac{V_e}{n}} \qquad (2.16)$$

In the article as a percent point for t distribution, the symbol in Fig. 2 .8 is used. Namely, t(ϕ, P) is plotted so that the area located on the right of that point will be P/2 in t distribution of degree of freedom ϕ or, in other words, so that the probability of being greater than that point will be P/2.

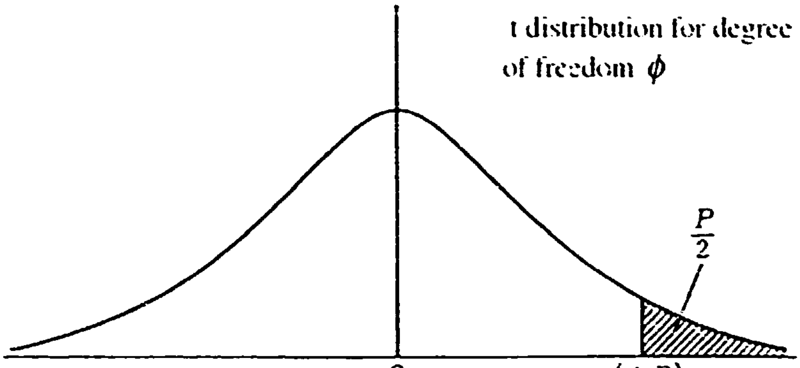


Fig. 2.8 Percent point for t distribution

The fact that the estimated value for population mean point at level A_i is a mean of data tested at level A_i will commonly be understandable. It holds true for all experiments taken up in the article. Theoretically,

$$E\{\bar{x}_{i\cdot}\} = E\{\mu + \alpha_i + \bar{\varepsilon}_{\cdot}\} = \mu + \alpha_i \qquad (2.17)$$

Therefore, $\bar{x}_{i\cdot}$ is unbiased estimator for population mean $\mu + \alpha_i$ at level A_i. (For calculation of equation (2.17), see §2.7.)

Generally, the confidence interval with 95% of coefficient for population mean is obtained by:

$$(\text{Estimated value of point}) \pm (\underbrace{\phi}_{\text{Degree of freedom for estimated variance}}, 0.05)\sqrt{\text{estimated variance of estimated value of point}} \qquad (2.18)$$

Let us obtain the confidence interval for $\mu + \alpha_i$ at 95%. The estimated value of point is $\bar{x}_i$ and its variance is $V(\bar{x}_i) = \frac{1}{n}\sigma^2$

From the fact that σ^2 is estimated by V_e and that the degree of freedom for V_e is ϕ_e, equation (2. 16) is obtained.

Since testing of A by the variance analyzing Fig. is testing of the hypothesis that there be no difference at all between levels of A, a significant difference may not exist between 2 given levels even if there is a significant difference within A. A significant difference between levels A_i and A_k is deemed existent (significant level α) when:

$$|\bar{x}_{i\cdot}-\bar{x}_{k\cdot}| > t(\phi_e, \alpha)\sqrt{\left(\frac{1}{n}+\frac{1}{n}\right)V_e} \tag{2.19}$$

The value of right side in equation (2.19) is referred to as a least significant difference and is represented by symbol lsd.

Equation (2. 19) has been deducted by completely the same approach as testing the difference in 2 populatiop means. Please note particularly that, for estimating the variance σ^2, V_e calculated with other data together is employed .

V_e is unbiased estimator of variance σ^2 for experimental error. Therefore, it is also necessary to compare V_e with the empirical value of error variance.

Calculation example

Let us take up example problem 2.1. The testing has revealed differences within A. Then, let us obtain the optimum level of A.

The estimated point value of populatioh mean of each level of A is:

$$\hat{\mu}(A_1) = \bar{x}_{1\cdot} = 140+\frac{(-4)}{5} = 139.2$$

$$\hat{\mu}(A_2) = \bar{x}_{2\cdot} = 140+\frac{16}{5} = 143.2$$

$$\hat{\mu}(A_3) = \bar{x}_{3\cdot} = 140+\frac{31}{5} = 146.2$$

$$\hat{\mu}(A_4) = \bar{x}_{4\cdot} = 140+\frac{(-20)}{5} = 136.0$$

In the confidence interval of 95% of population mean for level A_i, it has a width of:

$$t(\phi_e,\ 0.05)\sqrt{\frac{V_e}{n}} = t(16,\ 0.05)\sqrt{\frac{11.53}{5}}$$

$$= 2.120\times 1.52 = 3.2$$

Therefore,

$$A_1: \ 139.2 \pm 3.2 = (136.0, \ 142.4)$$
$$A_2: \ 143.2 \pm 3.2 = (140.0, \ 146.4)$$
$$A_3: \ 146.2 \pm 3.2 = (143.0, \ 149.4)$$
$$A_4: \ 136.0 \pm 3.2 = (132.8, \ 139.2)$$

They are indicated by Fig. 2.9.

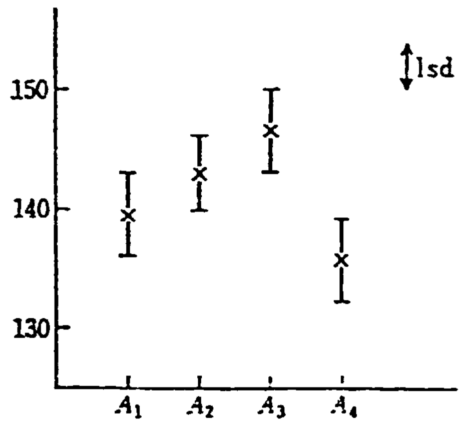


Fig. 2.9 Estimation of populaticn mean at level A

Fig. 2.10 Significant difference between levels of A

	A_2	A_3	A_4
A_1	4.0	7.0*	3.2
A_2		3.0	7.2*
A_3			10.2*

Fig. 2.9 reveals that level A_3 is optimum. Let us examine significant difference from current level A_1, etc. When the significant level is 5%, the least significant difference is:

$$\text{lsd} = t(\phi_e, \ 0.05)\sqrt{\frac{2}{n}V_e} = t(16, \ 0.05)\sqrt{\frac{2 \times 11.53}{5}} = 4.6$$

Therefore, the significant difference between 2 levels is as given in Fig. 2.10. It leads us to judge that, compared with current catalyst A_1, only A_3 increases the production quantity significantly.

Which level to select definitely must natually be determined upon taking into account the cost, operability and other conditions .

§2.6 When repeat count differs from one level to another

In the discussion heretofore, the repeat count at each level remained n but it may be different from one level to another. In the latter case, however, the data analysis differs partly. That section only will be explained.

Assume that the repeat count is n_1 at level A_1, n_2 at level A_2, ..., n_a at level A_a. The total number of assays is $N = n_1 + n_2 + ... + n_a$.

The variance analyzing Fig. is as given in Fig. 2.11. We have only to employ calculation formula (2 .14) for calculating each sum of squares. To obtain the degree of freedom also, we resort to already explained rules.

Fig. 2.11 Variance analyzing Fig. (when repeat count is different)

Variation factor	Sum of squares	Degree of freedom	Mean square	F0	Expected square mean
Within A	S_A	$\phi_A = a-1$	$V_A = \frac{S_A}{\phi_A}$	$\frac{V_A}{V_e}$	$\sigma^2 + \frac{1}{a-1}\sum_i^a n_i a_i^2$
Error	S_e	$\phi_e = N-a$	$V_e = \frac{S_e}{\phi_e}$		σ^2
Total	S_T	$\phi_T = N-1$			

For estimation afer the testing, equation (2. 16) has only to be modified into:

$$\bar{x}_{i\cdot} \pm t(\phi_e,\ 0.05)\sqrt{\frac{V_e}{n_i}} \qquad (2.20)$$

and equation (2.19) into:

$$|\bar{x}_{i\cdot} - \bar{x}_{k\cdot}| > t(\phi_e,\ \alpha)\sqrt{\left(\frac{1}{n_i}+\frac{1}{n_k}\right)V_e} \qquad (2.21)$$

Chapter 3 Design of two dimensions

The chapter discusses experiments having 2 factors (A and B). As already explained in Chapter I. the single factor experiment where a single factor is taken up at a time is not a good solution and the experiment must test all combinations of levels of A and B.

Here. the experiments are for 2 factors. Two-factor experiment is often referred to as a design of two dimensions and that term will be used in the article.

§3.1 What is design of two dimensions?

When factors A and have "a" and b levels. respectively,there are $a\,b$ combinations of levels of A and B. If each level combination is repeatedly tested b times, the total number of assays will be $a\,b\,n$. All of them are tested in a random sequence.

When n =1 or when each level combination is tested only once. it is referred to as a design of two dimensions without repetition. To distinguish from it, the present design will be designated as a **design of two dimensions with repetition**, which .can also be said an experiment by completely randomized
design .

Example problem 3 . 1
On a process of manufacturing certain synthetic resin moldings, with a view to examining the product's deflective strength, 4 levels (A_1 = 140, A_2 =160, A_3 = 180, A_4 = 200 (kg/cm^2) have been selected for forming pressure (A). and 3 levels (B_1 = 160, B_2 = 180, B_3 =200 (°C) for temperature (B). Because interactions between 2 factors had to be checked according to past experiments, it has been decided to test combinations of levels of 2 factors 2 times each and totally 24 assays have been carried out in a random sequence.

Obtained data is as given in Fig. 3.1. Analyze the data and give a conclusion. --

Fig. 3.1 Deflective strength (kg/cm²)

$A \backslash B$	B_1	B_2	B_3
A_1	17.1 17.0	17.3 17.5	17.4 17.1
A_2	17.1 17.3	17.8 17.4	17.6 17.5
A_3	17.4 17.6	17.8 18.1	17.8 17.5
A_4	17.4 17.2	17.5 17.2	17.1 17.4

The experimental data of design of two dimensions with repetition can generally be expressed x_{ijk} where subscript i denotes the level of factor A, j the level of factor B, and k the repetition number. I. e., x_{ijk} indicates kth experimental data with level combination A_iB_j. The experimental data can be summarized as shown in Fig. 3.2.

The same as for the design of one dimension, use the symbols $\chi_{i\cdot\cdot}$, $\bar{\chi}_{i\cdot\cdot}$, $\chi_{\cdot j\cdot}$, $\bar{\chi}_{\cdot j\cdot}$, $\chi_{ij\cdot}$, $\bar{\chi}_{ij\cdot}$, $\chi_{\cdot\cdot\cdot}$, $\bar{\chi}_{\cdot\cdot\cdot}$ For example,

$$x_{ij\cdot} = \sum_{k=1}^{n} x_{ijk} = \text{(sum of experimental data with } A_iB_j\text{)}$$

$$\bar{x}_{ij\cdot} = \frac{1}{n} x_{ij\cdot} = \text{(mean of experimental data with } A_iB_j\text{)}$$

Fig. 3.2 Data of design of two dimensions with repetition

$A \backslash B$	B_1	B_2	$\cdots$	B_b	sum	mean
A_1	x_{111} $\vdots$ x_{11n}	x_{121} $\vdots$ x_{12n}	$\cdots$	x_{1b1} $\vdots$ x_{1bn}	$x_{1\cdot\cdot}$	$\bar{x}_{1\cdot\cdot}$
A_2	x_{211} $\vdots$ x_{21n}	x_{221} $\vdots$ x_{22n}	$\cdots$	x_{2b1} $\vdots$ x_{2bn}	$x_{2\cdot\cdot}$	$\bar{x}_{2\cdot\cdot}$
$\vdots$	$\vdots$	$\vdots$		$\vdots$	$\vdots$	$\vdots$
A_a	x_{a11} $\vdots$ x_{a1n}	x_{a21} $\vdots$ x_{a2n}	$\cdots$	x_{ab1} $\vdots$ x_{abn}	$x_{a\cdot\cdot}$	$\bar{x}_{a\cdot\cdot}$
sum	$x_{\cdot1\cdot}$	$x_{\cdot2\cdot}$	$\cdots$	$x_{\cdot b\cdot}$	$x_{\cdot\cdot\cdot}$	
mean	$\bar{x}_{\cdot1\cdot}$	$\bar{x}_{\cdot2\cdot}$	$\cdots$	$\bar{x}_{\cdot b\cdot}$		$\bar{x}_{\cdot\cdot\cdot}$

S3.2 Data model

Given that the popuration mean (true characteristic value) with level combination A_iB_j is μ_{ij} (see Fig. 3.3), since x_{ijk} is kth data for A_iB_j, it may be adequate to think that :

$$x_{ijk} = \mu_{ij} + \varepsilon_{ijk} \tag{3.1}$$

where

μ_{ij} :Population mean with A_iB_j
ε_{ijk}:Experimental error included in data x_{ijk}

When the model is analyzed with equation (3.1), this experiment can be regarded as an experiment of a design of one dimension having a single virtual factor AB having ab levels. (See Fig. 3.4.) Therefore, as the analysis of variance for design of one dimension proceeds, we obtain the following resolution (equation (3.2)) of total sum of squares and variance analyzing Fig. (Fig. 3.5).

Fig. 3.3 population mean for each level combination for A and B

A \ B	B_1	B_2	$\cdots$	B_j	$\cdots$	B_b	Mean
A_1	μ_{11}	μ_{12}	$\cdots$	μ_{1j}	$\cdots$	μ_{1b}	$\bar{\mu}_{1\cdot}$
A_2	μ_{21}	μ_{22}	$\cdots$	μ_{2j}	$\cdots$	μ_{2b}	$\bar{\mu}_{2\cdot}$
$\vdots$	$\vdots$	$\vdots$		$\vdots$		$\vdots$	$\vdots$
A_i	μ_{i1}	μ_{i2}	$\cdots$	μ_{ij}	$\cdots$	μ_{ib}	$\bar{\mu}_{i\cdot}$
$\vdots$	$\vdots$	$\vdots$		$\vdots$		$\vdots$	$\vdots$
A_a	μ_{a1}	μ_{a2}	$\cdots$	μ_{aj}	$\cdots$	μ_{ab}	$\bar{\mu}_{a\cdot}$
Mean	$\bar{\mu}_{\cdot 1}$	$\bar{\mu}_{\cdot 2}$	$\cdots$	$\bar{\mu}_{\cdot j}$	$\cdots$	$\bar{\mu}_{\cdot b}$	$\bar{\mu}_{\cdot\cdot}$

Fig. 3.4 Data array when design of one dimension is deemed

A_1B_1	A_1B_2	$\cdots$	A_aB_b
x_{111}	x_{121}	$\cdots$	x_{ab1}
$\vdots$	$\vdots$		$\vdots$
x_{11n}	x_{12n}	$\cdots$	x_{abn}

$$\underbrace{\sum_i^a \sum_j^b \sum_k^n (x_{ijk} - \bar{x}_{\cdots})^2}_{\text{Total sum of squares } (S_T)} \tag{3.2}$$

$$= \underbrace{n \sum_i^a \sum_j^b (\bar{x}_{ij\cdot} - \bar{x}_{\cdots})^2}_{\text{Sum of squares between A and B } (S_{AB})} + \underbrace{\sum_i^a \sum_j^b \sum_k^n (x_{ijk} - \bar{x}_{ij\cdot})^2}_{\text{Error sum of squares } (S_e)}$$

Here, sum of squares between A and B (S_{AB}) is a sum of squares of ab differences between levels if ab level combinations for A and B are considered as ab levels of a single virtual factor AB.

Fig. 3.5 Variance analyzing Fig. when assuming experiments of design of one dimension

Variation factor	Sum of squares	Degree of freedom	Mean square	F_0
Between A and B	S_{AB}	$ab-1$	V_{AB}	V_{AB}/V_e
Error	S_e	$ab(n-1)$	V_e	
Total	S_T	$abn-1$		

However, from the variance analyzing Fig. in Fig. 3.5. we can only test the virtual factor AB or know whether there is a significant difference among ab level combinations for A and B. What we want to know is whether A x B exists or not and, if not ,whether there is a difference between levels of A and B and, if in the affirmative, which level is the best. In order to obtain such information, sum of squares S_{AB} must appropriately be resolved so that the above-mentioned information can be obtained.

For this purpose, consider population mean μ_{ij} for $A_i B_j$ as a sum of main effect of A, main effect of B and interactive effect of A and B. Let us examine equality:

$$\mu_{ij} = \bar{\mu}_{..} + (\bar{\mu}_{i.} - \bar{\mu}_{..}) + (\bar{\mu}_{.j} - \bar{\mu}_{..}) + (\mu_{ij} - \bar{\mu}_{i.} - \bar{\mu}_{.j} + \bar{\mu}_{..}) \tag{3.3}$$

where,

$$\bar{\mu}_{i.} = \frac{1}{b}\sum_{j}^{b}\mu_{ij}, \qquad \bar{\mu}_{.j} = \frac{1}{a}\sum_{i}^{a}\mu_{ij}, \qquad \bar{\mu}_{..} = \frac{1}{ab}\sum_{i}^{a}\sum_{j}^{b}\mu_{ij}$$

(See Fig. 3.3.). Let us consider physical meaning of each term on the right side in equation (3.3).

$\bar{\mu}_{..}$ which is the overall mean for μ_{ij}, in the 1st term is a general mean and will be expressed by μ.

$\bar{\mu}_{i.}-\bar{\mu}_{..}$,which is a deviation from the total mean from mean $\bar{\mu}_{..}$ at level $\bar{\mu}_{i.}$ in the 2nd term is the effect at level A_i. Hereafter, it will be referred to as **the main effect** at level A_i or main effect of A and be expressed by α_i.

Since $\sum_{i}^{a}(\bar{\mu}_{i.} - \bar{\mu}_{..}) = 0$ $\quad \sum_{i}^{a}\alpha_i = 0$

$\bar{\mu}_{i.}-\bar{\mu}_{..}$,which is a deviation from the total mean from mean $\bar{\mu}_{..}$ at level $\bar{\mu}_{j}$, in the 3rd term is the effect at level B_i. Hereafter, it will be referred to as the main effect at level B_i or main effect of B and be expressed by β_i.

Since $\sum_{j}^{b}(\bar{\mu}_{.j}-\bar{\mu}_{..})=0 \qquad \sum_{j}^{b}\beta_j=0$

The 4th term is equal to μ_{ij} - (μ+ α_i + β_j) and is the remainder of a subtraction from the population mean of A_iB_j of general mean μ , main effect of A, α_i and main effect of B, β_j and, therefore, can be considered as expressing the interaction between A and B. It is a fact and can be ascertained as follows. Rewrite the 4th term into:

$$\mu_{ij} - \bar{\mu}_{i.} - \bar{\mu}_{.j} + \bar{\mu}_{..} = (\mu_{ij} - \bar{\mu}_{i.}) - (\bar{\mu}_{.j} - \bar{\mu}_{..})$$

$\mu_{ij}- \bar{\mu}_{i.}$ is the effect of level B_j when A is fixed at i and the mean for A's "a" levels is $\bar{\mu}_{.j}$ + $\bar{\mu}_{..}$ Therefore, μ_{ij} - $\bar{\mu}_{i.}$ - ($\bar{\mu}_{.j}$ - $\bar{\mu}_{..}$) is the quantity of expressing the effect of combining A_i and B_j or interaction A x B betwee A and B (reflect that the value is zero if A x B does not exist). From this fact, μ_{ij} - $\bar{\mu}_{i.}$ - $\bar{\mu}_{.j}$ + $\bar{\mu}_{..}$ is called **an interaction (effect)** of A and B and is represented by symbol $(\alpha\beta)_{ij}$.

Since $\sum_{i}^{a}(\mu_{ij}-\bar{\mu}_{i.}-\bar{\mu}_{.j}+\bar{\mu}_{..})=0$, and $\sum_{j}^{b}(\mu_{ij}-\bar{\mu}_{i.}-\bar{\mu}_{.j}+\bar{\mu}_{..})=0$

and $\sum_{i}^{a}(\alpha\beta)_{ij}=0 \qquad \sum_{j}^{b}(\alpha\beta)_{ij}=0$

I.e., the interactive effect is zero in terms of a sum for the subscript for one of A and B.

From the above. population mean μ_{ij} for A_iB_j will be considered as:

$$\mu_{ij} = \mu + \alpha_i + \beta_j + (\alpha\beta)_{ij} \qquad (3.4)$$

i.e.,

[Population mean for A_iB_j]
=(general mean) + [main effect of A] + [main effect of B]
+ [interactive effect of A and B]

Substituting the equation (3.1) with equation C 3.4) allows to set the data model as follows.

$$x_{ijk} = \mu + \alpha_i + \beta_j + (\alpha\beta)_{ij} + \varepsilon_{ijk} \qquad (3.5)$$

where

μ : General mean

α_i: Main effect of A: $\sum_{i}^{a} \alpha_i = 0$

β_j : Main effect of B: $\sum_{j}^{b} \beta_j = 0$

$(\alpha\beta)_{ij}$: Interactive effect of A and B: $\sum_{i}^{a} (\alpha\beta)_{ij} = 0$,

$\sum_{j}^{b} (\alpha\beta)_{ij} = 0$

ε_{ijk}: Error (variable) ; NID (0. σ^2)

Problem and approach

Based on the model and equation (3.5), what we want to know and statistical method for it will be as follows.

(1) Does an interaction A x B exist between A and B?
To verify it, we have only to test a hypothesis that A x B ?
does not exist (testing of A x B) or:

$$H_0:\ (\alpha\beta)_{11} = (\alpha\beta)_{12} = \dots = (\alpha\beta)_{ab} = 0$$

(2) When A x B may be considered inexistent, what are the optimum levels of A and B?
To verify it, test firstly a hypothesis that there is no difference between levels of A or:

$$H_0:\ \alpha_1 = \alpha_2 = \dots = \alpha_a = 0$$

and another hypothesis that there is no difference between levels of B or:

$$H_0:\ \beta_1 = \beta_2 = \dots = \beta_b = 0$$

(testing of A and B) and, if they are significant, estimate main effects α_i and β_j of A and B. The reason is that, when A x B does not exist, the optimum levels of A and B may be determined distinctly.

(3) If A x B may be considered existent, what are the optimum levels of A and B?
To verify it. just estimate the population mean of $A_i\beta_j$ or μ_{ij} (= μ + α_i + β_j + $(\alpha\beta)_{ij}$) since, if interaction A x B exists, the optimum levels of A and B could not be obtained distinctly and population mean μ_{ij} of all level combinations would have to be estimated to determine the optimum level combinations therefrom .

Note: The interaction between A and B has been represented by symbol $(\alpha\beta)_{ij}$ to prevent it from being confounded with main effect of A or α_i and main effect of B or β_j. Applying this rule is advantageous in that, by just looking at the symbol, we can readily know the relevant interaction for which that symbol is assigned. --

§3.3 Analysis of variance

For testing A x B, A and B, the sum of squares betveen A and B or S_{AB} in equation (3.2) must be resolved into 3 components or 3 sums of squares expressing, firstly, the size of A x B, secondly, the difference betveen levels of A and, thirdly, the difference between levels of B, as given by:

$$\underbrace{n\sum_{i}^{a}\sum_{j}^{b}(\bar{x}_{ij.}-\bar{x}_{...})^2}_{\substack{\text{Sum of squares between}\\ \text{A and B } (S_{AB})}} = \underbrace{nb\sum_{i}^{a}(\bar{x}_{i..}-\bar{x}_{...})^2}_{\substack{\text{Sum of squares within A}\\ (S_A)}} + \underbrace{na\sum_{j}^{b}(\bar{x}_{.j.}-\bar{x}_{...})^2}_{\substack{\text{Sum of squares within B}\\ (S_B)}}$$
$$+\underbrace{n\sum_{i}^{a}\sum_{j}^{b}(\bar{x}_{ij.}-\bar{x}_{i..}-\bar{x}_{.j.}+\bar{x}_{...})^2}_{\text{Sum of squares for A x B } (S_{AxB})} \tag{3. 6}$$

There may be no need any more of explaining that the 1st term on the right side corresponds to the sum of squares expressing the difference between levels of A or sum of squares vithin A or S_A and that the 2nd term corresponds to the sum of squares expressing the difference betveen levels of B or sum of squares within B or S_B. We can understand that the 3rd term on the right side corresponds to the sum of squares expressing the size of interaction A x B or sum of squares for A x B or S_{AxB} upon considering that the interactive effect of A and B or $(\alpha\beta)_{ij}$ is μ_{ij} - $\bar{\mu}_{i.}$ - $\bar{\mu}_{.j}$, + $\bar{\mu}_{..}$ and that $\bar{x}_{ij.}$, $\bar{x}_{i..}$, $\bar{x}_{.j.}$, $\bar{x}_{...}$ are estimated values of μ_{ij}, $\bar{\mu}_{i.}$, $\bar{\mu}_{.j}$, $\bar{\mu}_{..}$ To examine it further precisely, ve have only to substitute the sun of squares defining equation $\bar{x}_{ij.}$ - $\bar{x}_{i..}$ - $\bar{x}_{.j.}$ + $\bar{x}_{...}$ with data model (see Note 1).

Notes

1. Fact that $S_{A\times B}=n\sum_{i}^{a}\sum_{j}^{b}(\bar{x}_{ij.}-\bar{x}_{i..}-\bar{x}_{.j.}+\bar{x}_{...})^2$ is a sum of squares expressing the size of interaction A X B.

Data model equation (3.5) gives:

$$\begin{aligned} \bar{x}_{ij\cdot} &= \mu + \alpha_i + \beta_j + (\alpha\beta)_{ij} + \bar{\varepsilon}_{ij\cdot} \\ \bar{x}_{i\cdot\cdot} &= \mu + \alpha_i \qquad\qquad\qquad + \bar{\varepsilon}_{i\cdot\cdot} \\ \bar{x}_{\cdot j\cdot} &= \mu \qquad + \beta_j \qquad\qquad + \bar{\varepsilon}_{\cdot j\cdot} \\ \bar{x}_{\cdots} &= \mu \qquad\qquad\qquad\qquad + \bar{\varepsilon}_{\cdots} \end{aligned} \tag{3.7}$$

Therefore

$$\begin{aligned} \bar{x}_{ij\cdot} - \bar{x}_{i\cdot\cdot} - \bar{x}_{\cdot j\cdot} + \bar{x}_{\cdots} &= (\alpha\beta)_{ij} + (\bar{\varepsilon}_{ij\cdot} - \bar{\varepsilon}_{i\cdot\cdot} - \bar{\varepsilon}_{\cdot j\cdot} + \bar{\varepsilon}_{\cdots}) \\ &= (\alpha\beta)_{ij} + \text{(error)} \end{aligned}$$

Since an error is inherent, $S_{A\times B}$ is a sum of squares expressing the size of interaction A x B.

2. Equation (3.6) can be proven the same as for equation (2.6) in Chapter 2 .---

In short, from equation (3.2) and (3.6). the total sum of square is resolved into:

$$S_T = S_A + S_B + S_{A\times B} + S_e \tag{3.8}$$

It is advised to make equation (3.8) for resolving the total sum of squares correspond to data model equation (3.5). As is clear from model equation (3.5). factors causing variations to data are α_i (main effect of A). B $_j$ (main effect of B). $(\alpha\beta)_{ij}$ (effect of A x B)and ε_{ijk} (error).
Therefore, total sum of squares S_T will have to be resolved into sum of squares within A (S_A). sum of squares within B (S_B). sum of squares of A x B ($S_{A\times B}$) and error sun of squares (S_e). Therefore. equation (3.8) is obtained. Thereafter, based on the datd model. equation (3.8) for resolving into total sums of squares is directly deduced.

Fig. 3.6 Variance analyzing Fig.

Variation	Sum of square	Degree of freedom	Mean square sqaure	F_0	Expected mean factor
Within A	S_A	$\phi_A = a-1$	V_A	V_A/V_e	$\sigma^2 + bn\sigma_A^2$
Within B	S_B	$\phi_B = b-1$	V_B	V_B/V_e	$\sigma^2 + an\sigma_B^2$
$A\times B$	$S_{A\times B}$	$\phi_{A\times B} = (a-1)(b-1)$	$V_{A\times B}$	$V_{A\times B}/V_e$	$\sigma^2 + n\sigma_{A\times B}^2$
Error	S_e	$\phi_e = ab(n-1)$	V_e		σ^2
Total	S_T	$\phi_T = abn-1$			

$$\left(\sigma_A^2 = \frac{1}{a-1}\sum_i \alpha_i^2,\ \ \sigma_B^2 = \frac{1}{b-1}\sum_j \beta_j^2,\ \ \sigma_{A\times B}^2 = \frac{1}{(a-1)(b-1)}\sum_i\sum_j (\alpha\beta)_{ij}^2\right)$$

The variance analyzing Fig. is given in Fig. 3.6.
The fact that the degree of freedom of $S_{A\times B}$ is $\phi_{A\times B} = (a - 1)(b - 1)$ is obtained from the way of getting the degree of freedom discussed in chapter 2. In reality, hovever, use of a rule:

$$\phi_{A\times B} = \phi_A \times \phi_B \qquad (3.9)$$

is recommended. The rule holds even when there are 3 factors or more and can be expressed as "the degree of freedom of sum of squares for interactions between factors is a product of degrees of freedom of the factors". Obtain degree of freedem of S_e or ϕ_e by subtraction $\phi_e = \phi_T - \phi_A - \phi_B - \phi_{A\times B}$.

Testing

By examining the column of expected sum of squares in the variance analyzing Fig., the way of testing the afore-mentioned 3 hypotheses can be obtained. Let us give a testing method when the significant level is a.

In case of:

$$H_0: \ (\alpha\beta)_{11} = (\alpha\beta)_{12} = \dots = (\alpha\beta)_{ab} \qquad \text{(testing A x B)}$$

H_0 is rejected when $\dfrac{V_{A\times B}}{V_e} > F(\phi_{A\times B}, \phi_e; \alpha)$

In case of:

$$H_0: \ \alpha_1 = \alpha_2 = \dots = \alpha_a = 0 \qquad \text{(testing A)}$$

H_0 is rejected when $\dfrac{V_A}{V_e} > F(\phi_A, \phi_e; \alpha)$

In case of:

$$H_0: \ \beta_1 = \beta_2 = \dots = \beta_b = 0 \qquad \text{(testing B)}$$

H_0 is rejected when $\dfrac{V_B}{V_e} > F(\phi_B, \phi_e; \alpha)$

To calculate the sums of squares, do not directly use the defining equation for sum of squares given in equations (3.2) and (3.6) but the following formulas deformed so as to facilitate the calculation in the order given below.

$$
\begin{aligned}
CT &= \frac{x_{\cdot\cdot\cdot}^2}{abn} \\
S_T &= \sum_i^a \sum_j^b \sum_k^n x_{ijk}^2 - CT \\
S_A &= \sum_i^a \frac{x_{i\cdot\cdot}^2}{bn} - CT \\
S_B &= \sum_j^b \frac{x_{\cdot j\cdot}^2}{an} - CT \\
S_{AB} &= \sum_i^a \sum_j^b \frac{x_{ij\cdot}^2}{n} - CT \\
&= \frac{(\text{Sum of data for } A_1B_1)^2}{\text{No. of data for } A_1B_1} + \frac{(\text{Sum of data for } A_1B_2)^2}{\text{No. of data for } A_1B_2} \\
&\quad + \cdots + \frac{(\text{Sum of data for } A_aB_b)^2}{\text{No. of data for } A_aB_b} - CT \\
S_{A\times B} &= S_{AB} - S_A - S_B \\
S_e &= S_T - S_{AB}
\end{aligned}
\qquad (3.10)
$$

Here, sum of squares between A and B or S_{AB} is unnecessary for testing but is calculated as an auxiliary quantity for calculating the sum of squares for A x B or $S_{A\times B}$.
The rules for calculating the sums of squares vhich appeared heretofore are summarized below.

Calculating rules for sum of squares (1)

(l) Firstly, calculate correction term CT.

$$CT = \frac{(\text{Sum of all data})^2}{\text{No. of all data}}$$

(2) Total sum of squares S_T is:

S_T = (sum of squares of each data) - CT

(3) Rules held for sum of squares for a factor will be explained for factor A as example for the sake of easy understanding. Sum of squares within A or S_A is :

$$S_A = \frac{(\text{Sum of data at level } A_1)^2}{\text{No. of data at level } A_1} + \frac{(\text{Sum of data at level } A_2)^2}{\text{No. of data at level } A_2}$$

$$+ \dots + \frac{(\text{Sum of data at level } A_a)^2}{\text{No. of data at level } A_a} - CT$$

(4) Calculate the sum of squares for interaction of 2 factors in the following procedure. The interaction of 2 factors is represented by A x B.

1°) Calculate sum of squares betveen A and B or S_{AB} by:

$$S_{AB} = \frac{(\text{Sum of data for } A_1B_1)^2}{\text{No. of data for } A_1B_1} + \frac{(\text{Sum of data for } A_1B_2)^2}{\text{No. of data for } A_1B_2}$$

$$+ \dots + \frac{(\text{Sum of data for } A_aB_b)_2}{\text{No. of data for } A_aB_b} - CT$$

2°) Calculate sum of squares for A x B or $S_{A \times B}$ by:

$$S_{A \times B} = S_{AB} - S_A - S_B$$

(5) Obtain error sum of squares by subtracting the sum of squares of each factor from the total sum of squares.

Note: 3. Calculating rules for sum of squares (2) will be shown in Chapter 4. Practically, rules (1) will suffice.

Calculation examples
Let us proceed to an analysis of variance in example problem 3.1.

(i) Transforming the data

A transformation:

$$\mu_{ijk} = (x_{ijk} - 17.0) \times 10$$

changes values as given in Fig. 3. 7.

Fig. 3.7 Transformed values

A \ B	B_1	B_2	B_3
A_1	1 0	3 5	4 1
A_2	1 3	8 4	6 5
A_3	4 6	8 11	8 5
A_4	4 2	5 2	1 4

(ii) Checking the homoscedasticity
The experiment is repeated. Check the homoscedasticity of experimental errors by R control chart. Range R_i in each grade (square) is 1, 2, 3, 2, 4, 1, 2, 3, 3, 2, 3, 3. $\overline{R} = 29/12 = 2.4$. When n = 2, $D_4 = 3.267$. Therefore,

$$D_4\overline{R} = 3.267 \times 2.4 = 7.8$$

The range of each square is smaller than 7.8 and, therefore, may be regarded as homoscedastic. I.e., the experiment may be deemed well controlled.

(iii) Creating an auxiliary Fig.
To calculate a sum of squares, obtain a sum of values at each level combination of A and B and put it in the form of a Fig. (Fig. 3.8). It is called a Fig. of tvo dimensions A and B.

Fig. 3.8 Fig. of tvo dimensions A and B

A \ B	B_1	B_2	B_3	Total
A_1	1	8	5	14
A_2	4	12	11	27
A_3	10	19	13	42
A_4	6	7	5	18
Total	21	46	34	101

(iv) Calculating sums of squares

$$CT' = \frac{(101)^2}{24} = 425.0$$

$$S'_T = (1)^2+(0)^2+\cdots+(1)^2+(4)^2-425.0 = 170.0$$

$$S'_A = \frac{(14)^2+(27)^2+(42)^2+(18)^2}{6}-425.0 = 77.2$$

$$S'_B = \frac{(21)^2+(46)^2+(34)^2}{8}-425.0 = 39.1$$

$$S'_{AB} = \frac{(1)^2+(8)^2+\cdots+(5)^2}{2}-425.0 = 130.5$$

$$S'_{A\times B} = S'_{AB}-S'_A-S'_B = 130.5-77.2-39.1 = 14.2$$

$$S'_e = S'_T-S'_{AB} = 170.0-130.5 = 39.5$$

The above sums of squares are for transformed values. To obtain sums of squares for initial data, divide them through $(10)^2$

Note 4: When the repeat count is 2, the error sum of squares S_e is calculated by:

$$S_e = \frac{1}{2}\sum_i R_i^2 \qquad (3.11)$$

where R_i is the range at each square. Let us calculate an error sum of squares by equation (3.11).

$$S'_e = \frac{1}{2}\{(1)^2+(2)^2+\cdots+(3)^2\} = \frac{79}{2} = 39.5$$

(v) Variance analyzing Fig. . .

The variance analyzing Fig. is shown in Fig. 3.9.
Testing has revealed that A x B is not significant but that A is 1% significant, and B 5% significant..

Fig. 3.9 Variance analyzing Fig. for example problem 3.1

Variation factor	Sum of squares	Degree of freedom	Mean Square	Fo
Pressure (A)	0.772	3	0.2573	7.82**
Temperattire (B)	0.391	2	0.1955	5.94*
A x B	0.142	6	0.0237	—
Error (e)	0.395	12	0.0329	
Total	1.700	23		

(vi) Pooling in error term

In the above example, interaction A x B was not significant.
It means that the hypothesis of $\sigma^2_{A \times B} = 0$ (or $(\alpha\beta)_{11}=(\alpha\beta)_{12}=...=(\alpha\beta)_{ab}=0$ has not been rejected. From this fact, we will assume "$\sigma^2_{A \times B}$ is zero" (somewhat problematic). Then, as is evident from the column of expected sum of squares in the variance analyzing Fig. in Fig. 3.6, the sum of squares for A x B is the same as error sum of squares. Therefore, there is a notion of considering $S_{A \times B}$ and S_e integrated together as a new error sum of squares.

Building a sum of sqaures of insignificant factor into an error sum of squares is referred to as **pooling in error term**.
In the present article, pooling will not be resorted to except in Chapters 6-9.

For example, let us pool A x B into the error term in the above example.

The sum of squares of factors and degree of freedom will be added to each error term. Therefore, new error sum of squares S_e' and its degree of freedom ϕ_e' are given by:

$$S_e' = S_{A \times B} + S_e$$
$$\phi_e' = \phi_{A \times B} + \phi_e$$

Fig. 3.10 Variance analyzing Fig. after pooling

Variation factor	Sum of squares	Degree of freedom	Mean Square	Fo
Pressure (A)	0.772	3	0.2573	8.63**
Temperattire (B)	0.391	2	0.1955	6.56**
Error (e')	0.537	18	0.0298	
Total	1.700	23		

Its results constitute thd variance analyzing Fig. in Fig. 3 . 10.

§3.4 Determination of optimum levels

2 cases below must be considered separately.
(I) When interaction A x B may be deemed inexistent
In this case, the optimum level may be determined distinctly for A and B. When comparing the factor levels , the same as for design of one dimension, the level effect plus general mean (μ) is referred to as the level's

population mean to compare with. It must be noted that its value itself is not meaningful and is only used for comparing the levels with.
Estimating the population mean of level A_i $(= \mu + \alpha_i)$

Point estimation: $\bar{x}_{i..}$ = [mean of data at level A_i] (3.12)

95% confidence interval: $\bar{x}_{i..} \pm t(\phi_e,\ 0.05)\sqrt{\frac{V_e}{bn}}$ (3.13)

Least significant difference (lsd) for judging the significant difference between 2 levels of factor A is:

$$\text{lsd}(A) = t(\phi_e,\ 0.05)\sqrt{\frac{2}{bn}V_e} \quad (3.14)$$

(5% significant level).

Estimating B_j level population mean $(= \mu + \beta_j)$

Point estimation: $\bar{x}_{.j.}$ = [mean of data at level B_j] (3.15)

95% confidence interval: $\bar{x}_{.j.} \pm t(\phi_e,\ 0.05)\sqrt{\frac{V_e}{an}}$ (3.16)

(2) When interaction A x B may be deemed existent
In this case, the optimym level may not be determined for A and B distinctly but for combined level of A and B.
Estimating the population mean of $A_iB_j (= \mu + \alpha_i + \beta_j + (\alpha\beta)_{ij})$

Point estimation: $\bar{x}_{ij.}$ [mean of data at A_iB_j] (3.17)

95% confidence interval: $\bar{x}_{ij.} \pm t(\phi_e,\ 0.05)\sqrt{\frac{V_e}{n}}$ (3.18)

Least significant difference (lsd) for judging the significant difference among levels of A and B is:

$$\text{lsd}(AB) = t(\phi_e,\ 0.05)\sqrt{\frac{2}{n}V_e} \quad (3.19)$$

(5% significant level).

Taking advantage of the occasion of determining an optimum level combination for A and B by these formulas, plot the estimated population mean $\bar{x}_{ij.}$ for A_iB_j as depicted in Fig. 3.11. Carefully observing it helps us to knov the aspect of interaction A x B. It is also important to study whether the interaction can technically be justified or not.

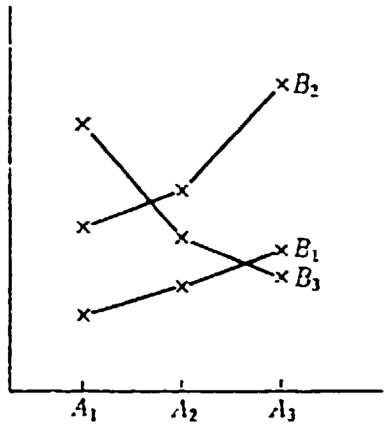


Fig. 3.11 Aspect of A x B

§3.5 Estimation of process mean

After determining the optimum level of each factor, the population mean at this optimum level combination may be estimated. It is referred to as an estimation of process mean. It is intended for rating how good results will be obtained under the optimum conditions obtained by the experiment compared vith the current working conditions.

Suppose that A and B are significant and that the optimum level combination is A_iB_j. The population mean is $\mu + \alpha_i + \beta_j + (\alpha\beta)_{ij}$ when A x B exists or $\mu + \alpha_i + \beta_j$ when A x B does not exist. When A x B exsist, the population mean for A_iB_i has only to be estimated by equations (3.17) and (3.18). When A x B does not exist, on the other hand, estimation and testing of the population mean at A_iB_j involve somewhat troublesome discussions. The section will briefly explain them.

Estimation of process mean **when A x B is not significant but when A and B are significant.**

Point estimation for population mean at A_iB_j $(= \mu + \alpha_i + \beta_j)$

Since there is no interaction, mean $\bar{x}_{ij.}$ of data at A_iB_j is also an estimated value of $\mu + \alpha_i + \beta_j$ but we will use a value estimated with combination of various means:

$$\bar{x}_{i..} + \bar{x}_{.j.} + \bar{x}_{...}$$

= (mean of data at A_i) + (mean of data at B_j)

- (mean of all data) (3.20)

because the latter is the more accurate.

The procedure for creating the estimated value and equation (3.20) is as follows.

1°) Rewrite population mean to estimate $\mu + \alpha_i + \beta_j$ into:

$$(\mu + \alpha_i) + (\mu + \beta_j) - \mu$$

It is a way "main effect is always accompanied by μ and, finally, the excess or shortage of μ is readjusted".

2°) μ is estimated by mean of all data or $\bar{x}...$, $\mu + \alpha_i$ by mean of data at level A_i or $\bar{x}_{i..}$ and $\mu + \beta_j$ by mean of data at level B_j or $\bar{x}_{.j.}$. As an estimated value of $\mu + \alpha_i + \beta_j$ therefore, equation (3.20) is obtained.

Note: 1. The fact that the estimated value and equation (3.20) are unbiased estimator of $\mu + \alpha_i + \beta_j$ is clear because use of equation (3.7) gives:

$$E\{\bar{x}_{i..}+\bar{x}_{.j.}-\bar{x}...\} = E\{\mu+\alpha_i+\beta_j+\bar{\varepsilon}_{i..}+\bar{\varepsilon}_{.j.}-\bar{\varepsilon}...\} = \mu+\alpha_i+\beta_j$$

The estimated value and equation (3.20) are more accurate than estimated value $\bar{x}_{ij.}$ because equation (3.20) has a smaller variance. ---

Interval estimation for population mean at $A_iB_j (= \mu + \alpha_i + \beta_j)$

Use the general formula (equation (2.18)) given in Chapter 2.
The variance of estimated value $\bar{x}_{i..} + \bar{x}_{.j.} - \bar{x}...$ is $((a + b - 1)/ abn)\sigma^2$ (see Note 3) and, therefore, 95% confidence interval of $\mu + \alpha_i + \beta_j$ is:

$$(\bar{x}_{i..}+\bar{x}_{.j.}-\bar{x}...)\pm t(\phi_e,\ 0.05)\sqrt{\frac{a+b-1}{abn}V_e} \tag{3.21}$$

By the vay, it is a little troublesome to calculate the variance of an estimated process mean such as by equation (3.20). So, a rule is proposed for formally obtaining the variance. The variance of estimated process mean is set to $(1/n_e)\sigma^2$ where n is an **effective repeat count**. By **Ina's rule** for obtaining an effective repeat count, $1/n_e$ is obtained as:

$$\frac{1}{n_e}=\frac{1}{bn}+\frac{1}{an}-\frac{1}{abn}=\frac{a+b-1}{abn} \tag{3.22}$$

This rule examines only numbers averaged by of each term of the estimated process mean with 1 as numerators and those numbers as denominators, the signs and coefficients remaining unchanged as given in equation (3.22). Equation (3.20), where $\bar{x}_{i..}$ is a mean of bn values, $\bar{x}_{.i.}$ a mean of "an" values, and $\bar{x}...$ a mean of abn values, gives equation (3.22).

In field, an experiment may be conducted afresh vith optimum level combination A_iB_j for the sake of reconfirmation of experimental results. What a data is anticipated by this experiment? Given above is the confidence interval for population mean and not for experimental data at,

A_iB_j. When carrying out r confirmation assays at A_iB_j, 95% confidence interval for mean of r data is given by:

$$(\bar{x}_{i..}+\bar{x}_{.j.}-\bar{x}_{...})\pm t(\phi_e,\ 0.05)\sqrt{\left(\frac{1}{r}+\frac{a+b-1}{abn}\right)V_e} \quad (3.23)$$

Therefore, if the mean of data for r confirmation assays is included in the above confidence interval, the said experimental result may be regarded as appropriate.

Calculation example

Let us take example problem 3.1 again and proceed to an estimation after analysis of variance. The testing reveals that A x B is not significant but A and B are. Here, we vill use the variance analyzing Fig. when not pooling (Fig. 3.9) in discussing the subject.

(vii) Deterdmining the optimum level of factor found significant

Since A x B may be regarded as inexistent, obtain the optimum level for A and B distinctly.

From equation (3.12), the point estimate for population mean at level A_i is:

$$\hat{\mu}(A_1)=\bar{x}_{1..}=\frac{14}{6}\times\frac{1}{10}+17.0=17.23$$

$$\hat{\mu}(A_2)=\bar{x}_{2..}=\frac{27}{6}\times\frac{1}{10}+17.0=17.45$$

$$\hat{\mu}(A_3)=\bar{x}_{3..}=\frac{42}{6}\times\frac{1}{10}+17.0=17.70$$

$$\hat{\mu}(A_4)=\bar{x}_{4..}=\frac{18}{6}\times\frac{1}{10}+17.0=17.30$$

From equation (3.13), 95% confidence interval for population mean at level A_i is:

$$t(12,\ 0.05)\sqrt{\frac{0.0329}{3\times2}}=2.179\times0.074=0.16$$

It gives Fig. 3.13 as a graph for estimating the population mean at each level of A.

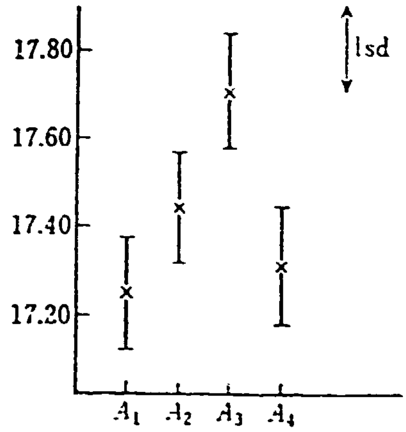


Fig. 3.13 Estimation of population mean at level A_i

The least significant difference for comparing 2 levels of A is from (significant level 5%) and equation (3.14),

$$\text{lsd}(A) = t(12,\ 0.05)\sqrt{\frac{2\times 0.0329}{3\times 2}} = 2.179\times 0.105 = 0.23$$

Since the difference between A_3 and A_2 is significant, level A_3 is optimum.

Likewise, for the population mean for level B_j, point estimate and 95% confidence interval are, from formulas (3.15) and (3.16) ,

B_1: 17.26±0.14
B_2: 17.58±0.14
B_3: 17.43±0.14

And also:

$$\text{lsd}(B) = t(12,\ 0.05)\sqrt{\frac{2\times 0.0329}{4\times 2}} = 0.20$$

They are illustrated in Fig. 3.14. There is no significant difference botveen B_2 and B_3 but level B_2 is deemed favorable.

Finally, the optimum level combination is A_3B_2. As already remarked, it must be noted when observing Fig.s 3.13 and 3.14 that the ordinate values are used only for comparing the levels with the other.

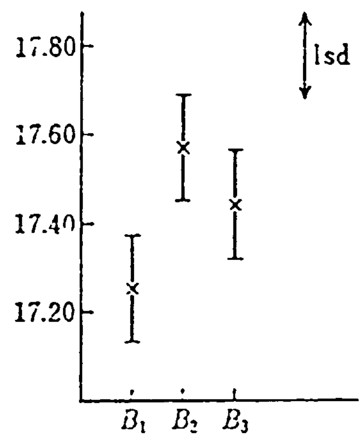


Fig. 3.14 Estimation of population mean at level B j

(viii) Estimating the process mean

Let us estimate the population mean with optimun level combination A_3B_2. The point estimate is:

$$\hat{\mu}(A_3B_2) = \widehat{\mu+\alpha_3+\beta_2} = \widehat{(\mu+\alpha_3)}+\widehat{(\mu+\beta_2)}-\hat{\mu}$$

= (mean of data at A_3) + (mean of data at B_2) - (mean of all data)

$$= 17.70+17.58-\left(\frac{101}{24}\times\frac{1}{10}+17.0\right) = 17.86$$

The effective repeat count of this estimated value is, according to Ina's rule,

$$\frac{1}{n_e} = \frac{1}{6}+\frac{1}{8}-\frac{1}{24} = \frac{6}{24} = \frac{1}{4}$$

Therefore, the 95% confidence interval is:

$$t(\phi_e,\ 0.05)\sqrt{\frac{V_e}{n_e}} = t(12,\ 0.05)\sqrt{\frac{0.0329}{4}} = 0.20$$

Thus, 95% confidence interval for population mean at A_3B_2 is:

17.86±0.20 = (17.66, 18.06)

(ix) Comparing the current conditions with optimum level combination

Supposing that the current level combination is A_2B_1, let us examine the significant difference from A_3B_2. It corresponds to the case of equation (3.25). The point estimate for population mean at A_2B_1 is:

$\hat{\mu}(A_2B_1)$ = (mean of data at A_2) + (mean of data at B_1) - (mean of all data)

$$= 17.45 + 17.26 - \left(\frac{101}{24} \times \frac{1}{10} + 17.0\right) = 17.29$$

Therefore, the estimated difference of population mean is:

$$\hat{\mu}(A_3B_2) - \hat{\mu}(A_2B_1) = 17.86 - 17.29 = 0.57$$

On the other hand,

$$t(\phi_e,\ 0.05)\sqrt{\left(\frac{2}{bn} + \frac{2}{an}\right)V_e} = t(12, 0.05)\sqrt{\left(\frac{2}{3\times 2} + \frac{2}{4\times 2}\right)\times 0.0329}$$
$$= 0.303$$

Therefore, from equation (3.25), we may judge that a significant difference exists between A_3B_2 and A_2B_1.

§3.6 Design of two dimensions without repetition

The experimental method of testing each one of *ab* level combinations for factors A (*a* levels) and B (*b* levels) is referred to as a **design of two dimensions without repetition**. It goes without saying that ab assays are executed in a random sequence.

As stated later, the design of two dimensions without repetition is an experimental method used only when the interaction betveen factors is known inexistent.

Data of a design of two dimensions without repetition can generally be represented by x_{ij}, where subscripts i and j indicate the level of factors A and B, respectively.

The experimental data can be summarized as given in Fig. 3. 15.

Fig. 3.15 Data of design of two dimensions without repetition

A \ B	B_1	B_2	$\cdots$	B_b
A_1	x_{11}	x_{12}	$\cdots$	x_{1b}
A_2	x_{21}	x_{22}	$\cdots$	x_{2b}
$\vdots$	$\vdots$	$\vdots$		$\vdots$
A_a	x_{a1}	x_{a2}	$\cdots$	x_{ab}

Data model

Since x_{ij} is an experimental data at A_iB_j, it is natural to consider that the data model is:

$$x_{ij} = (\text{population mean at } A_iB_j) + (\text{error})$$
$$= \mu + \alpha_i + \beta_j + (\alpha\beta)_{ij} + \varepsilon_{ij} \qquad (3.27)$$

where, μ is a general mean, α_i the main effect of A, β_j the main effect of B, $(\alpha\beta)_{ij}$ the effect of A x B, and ε_{ij} the error. In equation (3.27), by the way, both $(\alpha\beta)$ and ε have a subscript ij and $(\alpha\beta)_{ij}$ and ε_{ij} cannot be distinguished from each other. Namely, the interactive, effect and error cannot be discriminated. To distinguish them expressly, a repetition has only to be incorporated. By so doing, the repetition can evaluate experimental errors. Let us explain this fact referring to an example. Suppose that an experiment with a design of two dimensions without repetition has given a data shown in Fig. 3.16.

Fig. 3.16 Experimental data

A \ B	B_1	B_2
A_1	4.5	5.5
A_2	4.0	3.5

Changing B from B_1 to B_2 increases the data by 1.0 in case of A_1 but, on the other hand, decreases by 0.5 in case of A_2. It means that the effect of B depends on the level of A and that A and B are interactive. However, we can imagine also that, at A_2B_2, the experimental data of 3.5 might have wrongly been obtained on account of experimental error instead of true 5.0 or so. If so, A and B would not be interactive. Not knowing the experimental error magnitudes, we cannot reach any conclusion from this data only.

Thus, the design of two dimensions without repetition supposes that A and B are not interactive. And the data model is set to:

$$x_{ij} = \mu + \alpha_i + \beta_j + \varepsilon_{ij} \qquad (3.28)$$

where

μ : General mean

α : Main effect of A; $\sum_{1}^{a} \alpha_i = 0$

β_j: Main effect of B; $\sum_{j}^{b} \beta_j = 0$

ε_{ij}: Error (variable); NID(0, σ^2)

Analysis of variance

According to data model equation (3.28), factors affecting the data are main effect of A, (α_i), main effect of B, (β_j) and error (ε_{ij}). Therefore, the total sum of squares is resolved into:

$$S_T = S_A + S_B + S_e$$

For calculating the total sum of squares (S_T), sum of squares within A (S_A), sum of squares within B (S_B) and error sum of squares (S_e), resort to calculating rule (I) for sum of squares described in §3.3. How to obtain the degree of freedom is as already explained. Thus, we will have a variance analyzing Fig. in Fig. 3.17.

Fig. 3.17 Variance analyzing Fig.

Variation factor	Sum of squares	Degree of freedom	Mean square	F_0	Expected mean square
Within A	S_A	$\phi_A = a-1$	V_A	V_A/V_e	$\sigma^2 + b\sigma_A^2$
Within B	S_B	$\phi_B = b-1$	V_B	V_B/V_e	$\sigma^2 + a\sigma_B^2$
Error	S_e	$\phi_e = (a-1)(b-1)$	V_e		σ^2
Total	S_T	$\phi_T = ab-1$			

$$\left(\sigma_A^2 = \frac{1}{a-1}\sum_i^a \alpha_i^2,\quad \sigma_B^2 = \frac{1}{b-1}\sum_j^b \beta_j^2\right)$$

Problems

3.1 In the bonding process for ornamental plyvood. It is desired to find out such working conditions as to optimize the adhesive strength. Factors selected are bonding agent type (A) and open time (B), each having 3 levels. The current levels are A_1 and B_2. Since A and B may be interactive, the repeat count was 2 and totally 18 assays were carried out in a random sequence. Data obtained for the adhesive strength was as given in the Fig. below.

Adhesive strength (kg/cm²)

A \ B	B_1	B_2	B_3
A_1	30	37	42
	21	31	36
A_2	37	41	43
	31	35	36
A_3	30	44	46
	35	48	50

(1) Carry out an analysis of variance.
(2) Obtain conditions where the adhesive strength is an optimum and estimate the strength obtained at this time.
(3) Estimate the difference in adhesive strength between optimum and current conditions.

3.2 In order to raise the tensile strength of rolled products in a metal rolling factory, studies were pursued with 2 factors or reduction ratio (A) having 4 levels and rolling speed (B) having 3 levels. Within the range of these levels of A and B, A x B may be considered inexistent. So, as an experiment of a design of two dimensions without repetition, totally 12 assays were performed in a random sequence. Obtained data of tensile strength was as given in the Fig. below.

Tensile strength (kg/cm^2)

$A \backslash B$	B_1	B_2	B_3
A_1	77.4	77.6	77.7
A_2	77.7	78.1	78.5
A_3	78.0	78.4	78.7
A_4	78.2	78.1	78.3

(1) Carry out an analysis of variance and obtain conditions where the tensile strength is maximum.
(2) Compare the optimum conditions obtained in (1) and current conditions A_2B_2.

Chapter 4
Design of Experiments by Using an Orthogonal Array
- A two-level design -

Experiments conducted without experimenting with all the level combinations of factors picked up (fractional replication) can be easily designed by using an orthogonal Fig., as mentioned in Chapter 1. Chapter 2 shows you how to use a two-level orthogonal
array.

Of the several orthogonal arrays, this document is based on the orthogonal array developed by Genichi Taguchi (see Reference 3).

§ 4.1 A two-level orthogonal array

Fig. 4.1 shows one of the two-level orthogonal arrays. It is called "two-level" because the array gives two types of numbers: 1 and 2. It is called "orthogonal" because this Fig. has the characteristics mentioned below.

Characteristics of the two-level orthogonal array: When you pick two arbitrary columns, the numbers are arranged in four manners:

(1,1), (1,2), (2,1), (2,2)

Each of these arrays is sure to occur with the same frequency whichever two columns you pick up.

Let us check this characteristic by using Fig. 4.1. Pick up columns 1 and 2. The numbers are arranged in descending order: (1,1), (1,1), (1,2), (1,2), (2,1), (2,1), (2,2), and (2,2). Here, each of the four arrays (1,1), (1,2), (2,1), and (2,2) occurs twice. You can thus observe in the orthogonal array in Fig. 4.1 that, whichever pair of columns you pick, each of the arrays (1,1), (1,2), (2,1), and (2,2) occurs twice.

Fig. 4.1 Two-level orthogonal array L8(27)

No. \ Column #	1	2	3	4	5	6	7
1	1	1	1	1	1	1	1
2	1	1	1	2	2	2	2
3	1	2	2	1	1	2	2
4	1	2	2	2	2	1	1
5	2	1	2	1	2	1	2
6	2	1	2	2	1	2	1
7	2	2	1	1	2	2	1
8	2	2	1	2	1	1	2
Component symbol #	*a*	*b*	*a* *b*	*c*	*a* *c*	*b* *c*	*a* *b* *c*
Group #	1	2		3			

Let me explain the portions other than the orthogonal array itself. The column number represents the number of each column. No. represents the number of each row in the orthogonal array. Each line corresponds to the corresponding experiment number, with the row numbers representing the magnitude of the experiment involved, as you will see later. I will explain the component symbols and group numbers later. The orthogonal array in Fig. 4.1 is expressed in $L_8(2^7)$. L is a symbol representing an orthogonal array. I hear that the letter L is used because the orthogonal array is a developed version of the Latin square. Given below are the meanings of the various numbers included in this symbol.

$L_8(2^7)$
- 7 → Means that the column number is 7.
- 2 → Indicates that this is a two-level array.
- 8 → Indicates that the row number is 8 (this number corresponds to the magnitude of the experiment involved).

Note: In a two-level orthogonal array.
(number of columns) = (number of rows) - 1

This means that determining the number of rows automatically determines the number of columns. That is why the $L_8(2^7)$ is often called a "two-level orthogonal array with a magnitude of 8" because the number of columns (7) does not need to be mentioned.

Let me explain how such an orthogonal array is used in designing an experiment. Consider an experiment where you pick up four factors A, B, C, and D all of which are of the two-level type. Let there be no interaction among the factors. If you experiment with a four-factor arrangement, the total number of level combinations is 2 x 2 x 2 x 2=16, which means you will perform 16 experiments. As opposed to that, assume that you will perform 8 experiments as mentioned below by using an orthogonal array $L_8(2^7)$.

1°) The $L_8(2^7)$ contains 7 columns. Let A, B, C, and D correspond to any four of the seven columns. Let A correspond to column 1, B to column 2, C to column 3, and D to column 7 (Fig. 4.2).
2°) Regarding the numbers 1 and 2 in the orthogonal array as the levels of the factors made to correspond to those columns determines eight level combinations. In this example, Experiment 1 has $A_1B_1C_1D_1$, Experiment 2 $A_1B_1C_1D_2$,..., and Experiment 8 $A_2B_2C_1D_2$ (Fig. 4.2).
3°) You will experiment with the eight level combinations determined in 2°). You will perform these eight experiments in a random order.

Fig. 4.2

No. \ Column #	1 (A)	2 (B)	3 (C)	4	5	6	7 (D)		Level combination	Data
1	1	1	1	1	1	1	1	→	$A_1B_1C_1D_1$	$x_1=51$
2	1	1	1	2	2	2	2	→	$A_1B_1C_1D_2$	$x_2=32$
3	1	2	2	1	1	2	2	→	$A_1B_2C_2D_2$	$x_3=14$
4	1	2	2	2	2	1	1	→	$A_1B_2C_2D_1$	$x_4=14$
5	2	1	2	1	2	1	2	→	$A_2B_1C_2D_2$	$x_5=6$
6	2	1	2	2	1	2	1	→	$A_2B_1C_2D_1$	$x_6=19$
7	2	2	1	1	2	2	1	→	$A_2B_2C_1D_1$	$x_7=24$
8	2	2	1	2	1	1	2	→	$A_2B_2C_1D_2$	$x_8=14$

These experiments based on an orthogonal array do not test all level combinations of the factors. However, if there is no interaction as in this case, you can compare among the levels of A, B, C, and D based on the data obtained from the eight experiments. Let me explain why. Compare the four experiments with A_1 (Nos. 1 through 4) with the four experiments with A_2 (Nos. 5 through 9). The A_1 experiments test B_1 and B_2 twice each, while the A_2 experiments also test B_1 and B_2 twice each. The A_1 experiments test C_1 and C_2 twice each, while the A_2 experiments also test C_1 and C_2 twice each. Also, the A_1 experiments test D_1 and D_2 twice each, while the A_2 experiments also test D_1 and D_2 twice each. Based on these findings, compare the total of the data obtained from the A_1 experiments (the "total of the data obtained from the A_1-level experiments" will hereinafter be called the "total of the A_1 data") with the total of the A_1 data. The effects of the factors B, C, and D are equally included in both. Therefore, the

(Total of the A_1 data) - (Total of the A_2 data)

compares A_1 with A_2. This was to compare the levels of the factor A. The same is true of comparisons of the levels of the other factors B, C, and D. For example, the total of the B_1 data and the total of the B_2 data equally contain the effects of the other factors A, C, and D. A simple comparison of the total of the B_1 data with the total of the B_2 data constitutes a comparison of B_1 with B_2. These facts can be derived from the characteristic of an orthogonal array mentioned above.

In general, if the average of data of the factor A at each level contains an equal share of the effect of the factor B, and if the average of data of the factor B at each level contains an equal share of the effect of the factor A, we say that "the factor A is orthogonal to the factor B" or that "the main effect of the factor A is orthogonal to that of the factor B." In the above example, the factors A, B, C, and D are mutually orthogonal. The factors are mutually orthogonal in the factorial experiments (multi-factor arrangement) discussed in previous chapters as well.

Let us take the example of the two-factor arrangement in Fig. 4.3. The total of the A1 data and that of the A_2 data each contains an equal share of the effect of the factor B. And the total of the B_1 data, that of the B_2 data, and that of the B_2 data each contains an equal share of the effect of the factor A. Therefore, the factors A and B are mutually orthogonal.

Fig. 4.3 Two-factor arrangement

A \ B	B_1	B_2	B_3
A_1	( )	( )	( )
A_2	( )	( )	( )

In order to make it easy to compare the A_1 level with the A_2 level of the factor A by comparing the average of each, the factor A must be orthogonal to the other factors. This means that, in order to make it easy to predict the behavior of each factor in an experiment using several factors, the factors must be mutually orthogonal. The factors are naturally mutually orthogonal in a multi-factor arrangement that tests all level combinations of the factors picked up. However, under certain conditions (in the above example, under the condition where there is no interaction among A, B, C, and D), the factors can be made to be mutually orthogonal by experimenting with some--not all--of the level combinations. Then, what level combinations should we experiment with? The solution lies in an orthogonal array.

In addition to the orthogonal array in Fig. 4.1, there are other two-level orthogonal arrays: $L_4(2^3)$, $L_{16}(2^{15})$, $L_{32}(2^{31})$, $L_{64}(2^{63})$ (Attached Fig. 5).

§4.2 If there is no interaction among the factors

This section describes how to assign experiments by using an orthogonal array and how to analyze the data, when there is no interaction among the factors while all the factors are of the two-level type. The procedure for assigning experiments was explained in §4.1. Here is an outline:

1°) Assign the factors randomly to the columns in the orthogonal array. This orthogonal array must therefore contain more columns than there are factors picked up.
2°) Looking at the column numbers 1 and 2 to which factors are assigned determines the level combinations in each experiment number. That is, it determines the level combinations to be experimented with.
3°) Perform all experiments in a random order.

Problem 4.1 Let there be no interaction among the four factors A, B, C, and D. Assume that you have assigned the factors to the columns as shown in Fig. 4.2. In that case, you may want to make a Fig. called an assignment Fig., as shown in Fig. 4.4.
The eight level combinations to be experimented with come from Fig. 4.2. Perform these experiments in a random order.

Fig. 4.4 Assignment Fig.

Column #	1	2	3	4	5	6	7
Factor	A	B	C				D

The experimental data can be analyzed in exactly the same way as in a factorial experiment, because the factors are mutually orthogonal.

Let me take the example of Problem 4.1. In an experiment based on an orthogonal array, you regard the assignment Fig. as a data model. Therefore, based on the assignment Fig. in Fig. 4.4, the total of the sums of squares can be broken down into:

$$S_T = S_A + S_B + S_C + S_D + S_e$$

You can calculate each sum of squares according to the Rules for Calculating the Sums of Squares (§ 3.3). These calculation rules hold for the sums of squares that hold when the factors are mutually orthogonal. Then you can create a variance analysis Fig., develop an F ratio with regard to the error term, and test it. Estimates after this test can also be made in exactly the same way.

Let me give a precaution to be taken when calculating the sums of squares of two-level factors. For example, the sum of squares between A_1 and A_2 can be calculated by

$$S_A = \frac{(\text{sum of the } A_1 \text{ data})^2}{(\text{number of the } A_1 \text{ data items})} + \frac{(\text{sum of the } A_2 \text{ data})^2}{(\text{number of the } A_2 \text{ data items})} - CT. \quad (4.1)$$

On the other hand, if A is of the two-level type, it can be calculated by

$$S_A = \frac{(\text{sum of the } A_1 \text{ data - sum of the } A_2 \text{ data})^2}{(\text{total number of data items})} \quad (4.2)$$

Since Equation 4.2 is easier to calculate than Equation 4.1, Equation 4.2 is more often used.

Note: Proof that Equation 4.1 is equal to Equation 4.2: Where n is the number of replications at the A_1 and A_2 levels and the sums of data are A_1 and A_2,

$$S_A = \frac{(A_1)^2}{n} + \frac{(A_2)^2}{n} - \frac{(A_1+A_2)^2}{2n} = \frac{(A_1)^2+(A_2)^2-2(A_1)(A_2)}{2n}$$
$$= \frac{(A_1-A_2)^2}{2n}$$

Typical calculation

Assuming that, in the experiment in Problem 4.1, the data obtained comes from the right end of Fig. 4.2, conduct an analysis of variance.

$$CT = \frac{(\text{sum of all data})^2}{(\text{total number of data items})} = \frac{(174)^2}{8} = 3784.5$$

$$S_T = (\text{sum of the squares of individual data}) - CT$$
$$= 5186 - 3784.5 = 1401.5$$

$$S_A = \frac{(A_1-A_2)^2}{8} = \frac{(111-63)^2}{8} = 288.0$$

$$S_B = \frac{(B_1-B_2)^2}{8} = \frac{(108-66)^2}{8} = 220.5$$

$$S_C = \frac{(C_1 - C_2)^2}{8} = \frac{(121-53)^2}{8} = 578.0$$

$$S_D = \frac{(D_1 - D_2)^2}{8} = \frac{(108-66)^2}{8} = 220.5$$

$$S_E = S_T - S_A - S_B - S_C - S_D = 94.5$$

Therefore, the variance analysis Fig. is as shown in Fig. 4.5.

Fig. 4.5 Variance analysis Fig. for Problem 7.1

Cause of fluctuation	Sum of squares	Degree(s) of freedom	Mean square	F_o
A	288.0	1	288.0	9.14
B	220.5	1	220.5	7.00
C	578.0	1	578.0	18.35*
D	220.5	1	220.5	7.00
	94.5	3	31.5	
Total	1401.5	7		

In the above calculations, the sums of squares are calculated in the same way as in previous calculations. In an experiment based on an orthogonal array, the sums of each factor is often determined by using the sum of squares of columns to be defined later on. In a two-level orthogonal Fig., the sum $S_{(i)}$ of squares of column i can be defined as follows:

$$S_{(i)} = \frac{[(\text{Sum of the data where column } i \text{ is 1}) - (\text{Sum of the data where column } i \text{ is 2})]^2}{(\text{Total number of data items})} \quad (4.3)$$

or

$$S_{(i)} = \frac{(\text{Sum of the data where column } i \text{ is 1})^2}{(\text{Number of data items where column } i \text{ is 1})} + \frac{(\text{Sum of the data where column } i \text{ is 2})^2}{(\text{Number of the data items where column } i \text{ is 2})} - CT \quad (4.4).$$

If so, you can learn from Equation 4.2 or 4.1 that the sum of squares of each factor is equal to the sum of squares in the column to which that factor is assigned.

This leads to the conclusion that you can calculate the sum of squares as follows by using the sum of squares of the column:

1°) Calculate the sum of squares in each column.
In the experiment in Problem 4.1, you will calculate $S_{(1)}$, $S_{(2)}$,...$S_{(3)}$

2°) The total S_T of the sums of squares is equal to the total of the sums of squares of each column.
Based on the above, you can calculate S_T with the previous method and use the result to check your calculations. That is, in the experiment in Problem 4.1,

$$S_T = S_{(1)} + S_{(2)} + S_{(3)} + S_{(4)} + S_{(5)} + S_{(6)} + S_{(7)}$$
$$= (\text{sum of the squares of individual data}) - CT.$$

3°) The sum of squares of each factor is equal to the sum of squares in the column to which that factor is assigned. Also, the sum of squares of error is equal to the total of sums of squares in the column to which no factor is assigned. (You may infer from the above that errors are assigned to the empty columns.)

In the experiment in Problem 4.1,

$$S_A = S_{(1)},\quad S_B = S_{(2)},\quad S_C = S_{(3)},\quad S_D = S_{(7)},$$
$$S_e = S_{(4)} + S_{(5)} + S_{(6)}$$

4°) The degrees of freedom of the sum of squares of each factor can be calculated by considering that the sum of squares of one column has one degree of freedom and by checking to the total of the sums of squares of how many columns the above sum of squares equals.

In the experiment in Problem 4.1, $\phi_A = \phi_B = \phi_C = \phi_D = 1$.
Since S_e is equal to the total of the sums of squares of three columns, $\phi_e = 3$.

§ 4.3 If there is an interaction among the factors

The preceding section was based on the assumption that there is no interaction among the factors picked up. What happens if there is an interaction among them?

Pick up the factors A, B, C, and D all of which are of the two-level type, and let AxB exist. Assign the factors A, B, C, and D to the columns randomly as in the preceding section and assume that A is assigned to column 1, B to column 2, C to column 3, and D to column 7 as shown in Fig. 4.2. In that case, what effect does the existence of A x B have?

A close look at the effects of A and B on the four D_1 experiments and on the four D_2 experiments reveals that:

$$D_1:\ A_1B_1,\ A_1B_2,\ A_2B_1,\ A_2B_2,$$
$$D_2:\ A_1B_1,\ A_1B_2,\ A_2B_1,\ A_2B_2,$$

Both cases are experimented with under the conditions of A_1B_1, A_1B_2, A_2B_1, and A_1B_2, once under each condition. Therefore, D_1 and D_2 each takes an equal share of the effects of the factors A and B. Next, a close look at the effects of A and B on the four C_1 experiments and on the four C_2 experiments reveal that:

$$C_1:\ A_1B_1,\ A_1B_1,\ A_2B_2,\ A_2B_2,$$
$$C_2:\ A_1B_2,\ A_1B_2,\ A_2B_1,\ A_2B_1,$$

Now A and B do not give equal shares of effect. (But they are equal as shown in Section 4.1 when A x B does not hold.) Therefore, a comparison of the sum of the C_1 data with the sum of the C_2 data does not constitute a pure comparison of C_1 with C_2.

Now let us examine how A and B affect the C_1 and the C_2 sum, on the basis of the data model.

Express the main effect of A in α_1 and α_2, that of B in β_1 and β_2, that of C in γ_1 and γ_2, and that of D in δ_1 and δ_2. Since $\alpha_1 + \alpha_2 = 0$, $\beta_1 + \beta_2 = 0$, $\gamma_1 + \gamma_2 = 0$, $\delta_1 + \delta_2 = 0$ the magnitude of the difference between the A_1 level and the A_2 level is expressed by α_1. This is measured on the basis $\alpha_1 - \alpha_2 = \alpha_1 - (-\alpha_1) = 2\alpha_1$.

The A x B effect has previously been expressed as $(\alpha\beta)_{11}, (\alpha\beta)_{12}, (\alpha\beta)_{21}, (\alpha\beta)_{22}$. Among these, there is a relationship expressed as:

$$\sum_{i=1}^{2}(\alpha\beta)_{ij} = 0 \quad (j=1, 2), \qquad \sum_{j=1}^{2}(\alpha\beta)_{ij} = 0 \quad (i=1, 2)$$

That is, since the sum of rows and the sum of columns are zero in Fig. 4.6(a), the A x B effect can be expressed in $(\alpha\beta)_{11}$ and $(\alpha\beta)_{21}$ as shown in Fig. 4.6(b). In this case,

$$(\alpha\beta)_{11} + (\alpha\beta)_{21} = 0$$

Therefore, the magnitude of the interaction is expressed by $(\alpha\beta)_{11}$. And this is measured by:

$$(\alpha\beta)_{11} - (\alpha\beta)_{21} = (\alpha\beta)_{11} - (-(\alpha\beta)_{11}) = 2(\alpha\beta)_{11}$$

Fig. 4.6 Expressions of the A x B effect

(a)

B \ A	B_1	B_2
A_1	$(\alpha\beta)_{11}$	$(\alpha\beta)_{12}$
A_2	$(\alpha\beta)_{21}$	$(\alpha\beta)_{22}$

$\Longrightarrow$

(b)

B \ A	B_1	B_2
A_1	$(\alpha\beta)_{(1)}$	$(\alpha\beta)_{(2)}$
A_2	$(\alpha\beta)_{(2)}$	$(\alpha\beta)_{(1)}$

When the factorial effect is expressed with the above symbols, the data model becomes as follows:

$$\chi_1 = \mu + \alpha_1 + \beta_1 + (\alpha\beta)_{(1)} + \gamma_1 + \delta_1 + \varepsilon_1$$
$$\chi_2 = \mu + \alpha_1 + \beta_1 + (\alpha\beta)_{(1)} + \gamma_1 + \delta_2 + \varepsilon_2$$
$$\chi_3 = \mu + \alpha_1 + \beta_2 + (\alpha\beta)_{(2)} + \gamma_2 + \delta_2 + \varepsilon_3$$
$$\chi_4 = \mu + \alpha_1 + \beta_2 + (\alpha\beta)_{(2)} + \gamma_2 + \delta_1 + \varepsilon_4$$
$$\chi_5 = \mu + \alpha_2 + \beta_1 + (\alpha\beta)_{(2)} + \gamma_2 + \delta_2 + \varepsilon_5$$
$$\chi_6 = \mu + \alpha_2 + \beta_1 + (\alpha\beta)_{(2)} + \gamma_2 + \delta_1 + \varepsilon_6$$
$$\chi_7 = \mu + \alpha_2 + \beta_2 + (\alpha\beta)_{(1)} + \gamma_1 + \delta_1 + \varepsilon_7$$
$$\chi_8 = \mu + \alpha_2 + \beta_2 + (\alpha\beta)_{(1)} + \gamma_1 + \delta_2 + \varepsilon_8$$

where $\varepsilon_1, \varepsilon_2, \ldots, \varepsilon_8$ represent experimental errors.

Let us now think of comparing the A_1 level with the A_2 level. When you subtract the sum of the A_2 data from the sum of the A_1 data, $\mu, \beta, (\alpha\beta), \gamma, \delta$ all disappear. The result is:

(The sum of the A_1 data) - (sum of the A_2 data)
$= 4(\alpha_1 - \alpha_2) +$ (error).

Therefore,

(The average of the A_1 data) - (average of the A_2 data)
$= (\alpha_1 - \alpha_2) +$ (error).

This surely constitutes an A_1-A_2 comparison.
But note that, in Equation 4.5, the subscript to the corresponds exactly to that to $(\alpha\beta)$. This means that comparing the sum of the C_1 data with the sum of the C_2 data in order to compare C_1 with C_2 (that is, in order to calcu-

late $\gamma_1 - \gamma_2$) constitutes not only a C1-C2 comparison but also a comparison of $(\alpha\beta)_{(1)}$ with $(\alpha\beta)_{(2)}$, that is, an estimate of the AxB effect. The complete correspondence of the subscript to the $(\alpha\beta)$ to that of the γ can be considered to mean that "the difference between the sum of the data with number 1 and that of the data with number 2 in column 3 gives an estimate of A x B" because the subscript to the gamma is equal to the numbers in column 3. Therefore, if factor C is assigned to column 3 as exemplified above, the main effect of C and A x B effect are completely confounded. Therefore, when A x B exists, column 3 giving an estimate of A and B has only to be left blank without assigning a factor there. Then, A x B can be estimated from that column.

The above discussion reveals that assigning factor A to column 1, and factor B to column 2 causes column 3 to estimate A x B. It is referred to as "the interaction between factors assigned to column 1 and 2, respectively appears at column 3" or "the interaction between columns 1 and 2 is reflected on column 3".

Generally, which column reveals the interaction of factors assigned to 2 columns has only to be examined upon drawing a data model. In reality, however, the results summarized in a Fig. attached to the orthogonal array have only to be employed.

Fig. 4.7 gives columns where an interaction appears on orthogonal array $L_8(2^7)$. Interpretation of the array is as follows. To obtain a column of interaction between columns 2 and 4, for example, search for the number at the interaction of row 2 and column 4. It is 6. Thus, column 6 is involved in the interaction between columns 2 and 4.

Fig. 4.7 Interaction between 2 columns at $L_8(2^7)$.

Column \ Column	1	2	3	4	5	6	7
	(1)	3	2	5	4	7	6
		(2)	1	6	7	4	5
			(3)	7	6	5	4
				(4)	1	2	3
					(5)	3	2
						(6)	1
							(7)

Only the interaction between 2 factors has been discussed heretofore. The sum goes with interactions among 3 factors or more. Suppose there exists 3-factor interaction A x B x C. Since A x B x C can be considered as an interaction between A x B, A x B x C appears on the column where an interaction occurs between the column where A x B appears and column of C. Therefore, the column where A x B x C occurs has only to be left blank without assigning a factor there. In reality, however, an interaction involving 3 factors or more does not exist or, even if it does, its value may often be considered small enough. According to the design of experiment with an orthogonal array, interactions of 3 factors or kore are often deemed inexistent.

In short, when assigning experiments for when there is an interaction between factors, be sure to leave blank the column where an interaction may appear without assigning a factor or factorial effect and, in other respects, proceed the same as when there is no interaction between factors.

The experimental data has only to be analyzed the same as heretofore since all factorial effects cross at a right angle except the calculation of sum of squares of interaction. For example, the sum of squares of A x B is calculated by:

$$S_{A \times B} = S_{AB} - S_A - S_B \tag{4.6}$$

This value corresponds exactly to the sum of squares of a column where A x B appears. This fact could easily be understood considering that the difference between total of data for number 2 is the magnitude of A x B. Since the calculation of sum of squares of the column is easier than Equation (4.6), the sum of squares of the interaction is often obtained as a sum of squares of each column.

Thus, all data for experiments with orthogonal array can be analyzed by sum of sqaures of each column. Namely, calculate the sum of squares of each column and obtain the sum of squares of factors as a sum of squares of each column where those factors are assigned. The error sum of sqaures is the total of sums of squares of columns where factors are not assigned.

Problem 4.2 In order to identify the manufacturing conditions that minimize the quench distortion of a given piece of steel, you picked up the four factors A, B, C, and D and set all their levels be two-level. Assume that interactions A x B and B x C are likely to hold and that all other interactions are negligible. Design experiments for this case by using an orthogonal array.

Explanation: Since the factors are of the two-level type, use a two-level orthogonal array. Since there are four factors and two interactions, you need six columns in your orthogonal array. Use an orthogonal array $L_8(2^7)$ and consider how to make assignments.

Assign the interactive factors first. If you assign A to column 1 and B to column 2, A x B occurs in column 3. Therefore, keep column 3 empty with no factor assigned to it. If you assign C to column 4, B x C occurs in column 6. Therefore, keep column 6 empty with no factor assigned to it. (Since B is interactive with A and C, it may be well-advised to assign B first.) Since factor D is not interactive with other factors, you can assign it to either of the remaining columns (columns 5 and 7). Assume that you assign D to column 7.

The result is the assignment pattern shown in Fig. 4.8. The eight level combinations to be experimented with are as shown in the right-hand part of the Fig.. Perform these eight experiments in a random order.

Fig. 4.8 Assignments and experimental data in Problem 4.2

	A	B	(A×B)	C		(B×C)	D		
No. \ Column #	1	2	3	4	5	6	7	Level combination	Data
1	1	1	1	1	1	1	1	→ $A_1B_1C_1D_1$	0.24
2	1	1	1	2	2	2	2	→ $A_1B_1C_2D_2$	0.34
3	1	2	2	1	1	2	2	→ $A_1B_2C_1D_2$	0.38
4	1	2	2	2	2	1	1	→ $A_1B_2C_2D_1$	0.29
5	2	1	2	1	2	1	2	→ $A_2B_1C_1D_2$	0.51
6	2	1	2	2	1	2	1	→ $A_2B_1C_2D_1$	0.47
7	2	2	1	1	2	2	1	→ $A_2B_2C_1D_1$	0.23
8	2	2	1	2	1	1	2	→ $A_2B_2C_2D_2$	0.40

Problem 4.3 Assume that the experimental data obtained in Problem 4.2 are as given in the right end of Fig. 4.8 and analyze the data. The smaller the data, the more desirable they are.

Explanation: From the assignment Fig. in Fig. 4.8, assume that the total S_T of the sums of squares breaks down into:

$$S_T = S_A + S_B + S_C + S_D + S_{A\times B} + S_{B\times C} + S_e$$

Convert the data into

$$u_i = (x_i - 0.30) \times 100$$

and calculate the sums of squares of column regarding the converted values according to Fig. 4.9. In Fig. 4.9, the row entitled "Total" is designed to check the calculations.

Fig. 4.9 Calculating the sums of squares of column

Column #	1		2		3		4		5		6		7	
Level	1	2	1	2	1	2	1	2	1	2	1	2	1	2
Sum	5	41	36	10	1	45	16	30	29	17	24	22	3	43
Total	46		46		46		46		46		46		46	
Sum of squares of column	162.0		84.5		242.0		24.5		18.0		0.5		200.0	

Check:

$$S'_T = \text{(sum of squares of each data item)} - CT'$$
$$= (-6)^2 + (4)^2 + \dots + (10)^2 - \frac{(46)^2}{8} = 731.5$$

On the other hand, the total of the sums of squares of column

$$S'_T = S'_{(1)} + S'_{(2)} + \dots + S'_{(7)}$$
$$= 162.0 + 84.5 + \dots + 200.0 = 731.5$$

This check reveals that the calculations are correct.

To determine the sum of squares of column with regard to the original data, the sum of squares of column obtained here must be divided by $(100)^2$.

From the assignment Fig. (Fig. 4.8),

$S_A = S_{(1)} = 162.0 \times 10^{-4}$
$S_B = S_{(2)} = 84.5 \times 10^{-4}$
$S_C = S_{(4)} = 24.5 \times 10^{-4}$
$S_D = S_{(7)} = 200.0 \times 10^{-4}$
$S_{A \times B} = S_{(3)} = 242.0 \times 10^{-4}$
$S_{B \times C} = S_{(6)} = 0.5 \times 10^{-4}$
$S_e = S_{(5)} = 18.0 \times 10^{-4}$

The above results in a variance analysis as shown in Fig. 4.10.

Fig. 4.10 Variance analysis Fig. for Problem 4.3

Cause of fluctuation	Sum of squares	Degree(s) of freedom	Mean square	F_0
A	162.0×10^{-4}	1	162.0×10^{-4}	9.00
B	84.5×10^{-4}	1	84.5×10^{-4}	4.69
C	24.5×10^{-4}	1	24.5×10^{-4}	1.36
D	200.0×10^{-4}	1	200.0×10^{-4}	11.11
$A\times B$	242.0×10^{-4}	1	242.0×10^{-4}	13.44
$B\times C$	0.5×10^{-4}	1	0.5×10^{-4}	—
Error(e)	18.0×10^{-4}	1	18.0×10^{-4}	
Total	731.5×10^{-4}	7		

Since V_A, V_D, and $V_{A\times B}$ are larger than V, A, D, and A x B seems as if they were significant. But none of them are in fact significant because F(1,1;0.05)=161.0. This causes us to suspect that the testing precision is low because the error term has one degree of freedom. Then, if we pool for the error term C and BxC having mean squares equal or smaller than V and re-establish a variance analysis Fig., we will obtain a variance analysis Fig. as shown in Fig. 4.11. As a result, we find that A, D, and A x B are 5% significant.

Fig. 4.11 Variance analysis Fig. after pooling (Problem 4.3)

Cause of fluctuation	Sum of squares	Degree(s) of freedom	Mean square	F_0
A	162.0×10^{-4}	1	162.0×10^{-4}	11.33*
B	84.5×10^{-4}	1	84.5×10^{-4}	5.91
D	200.0×10^{-4}	1	200.0×10^{-4}	13.99*
$A\times B$	242.0×10^{-4}	1	242.0×10^{-4}	16.92*
Error(e')	43.0×10^{-4}	3	14.3×10^{-4}	
Total	731.5×10^{-4}	7		

Here, we will obtain the optimal level combination of A, B, and D. The point estimates of the population means of A_iB_j are

$$\hat{\mu}(A_1B_1) = \text{average of } A_1B_1 \text{ data} = 0.290$$
$$\hat{\mu}(A_1B_2) = \text{average of } A_1B_2 \text{ data} = 0.335$$
$$\hat{\mu}(A_2B_1) = \text{average of } A_2B_1 \text{ data} = 0.490$$
$$\hat{\mu}(A_2B_2) = \text{average of } A_2B_2 \text{ data} = 0.315$$

And the 95% confidence interval is

$$t(3, 0.05)\sqrt{\frac{14.3\times10^{-4}}{2}} = 0.086$$

The point estimates of the population means of D_1 and D_2 are

$$\hat{\mu}(D_1) = \text{average of } D_1 \text{ data} = 0.308$$
$$\hat{\mu}(D_2) = \text{average of } D_2 \text{ data} = 0.408$$

And the 95% confidence interval is

$$t(3, 0.05)\sqrt{\frac{14.3\times 10^{-4}}{4}} = 0.060$$

These are diagrammed in Fig.s 4.12 and 4.13.

Letting the optimal level combination be $A_1B_1D_1$, let us estimate its population mean. The population mean of $A_1B_1D_1$ can be considered to be

$$\begin{aligned}\mu(A_1B_1C_1) &= \mu + \alpha_1 + \beta_1 + (\alpha\beta)_{11} + \delta_1 \\ &= [\mu + \alpha_1 + \beta_1 + (\alpha\beta)_{11}] + [\mu + \delta_1] - \mu\end{aligned}$$

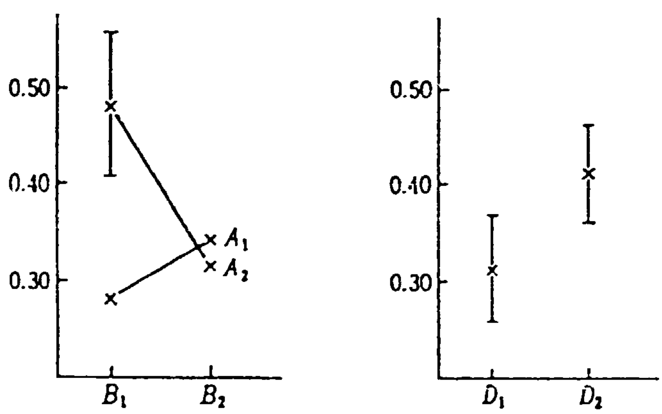


Fig. 4.12 Actual A x B   Fig. 4.13 Estimates of the population means of the D_1 level

Here, α, β, and δ represent the main effects of A, B, and D respectively. Therefore, the point estimate is

$$\begin{aligned}\hat{\mu}(A_1B_1S_1) &= \widehat{\mu+\alpha_1+\beta_1+(\alpha\beta)_{11}} + \widehat{\mu+\delta_1} - \hat{\mu} \\ &= (\text{average of the } A_1B_1 \text{ data}) \\ &\quad + (\text{average of the } D_1 \text{ data}) \\ &\quad - (\text{average of all data}) \\ &= 0.290 + 0.308 - 0.358 = 0.240\end{aligned}$$

The effective number of replications of this estimate is

$$\frac{1}{n_e}=\frac{1}{2}+\frac{1}{4}-\frac{1}{8}=\frac{5}{8}$$

according to Ina's rules. Therefore, the 95% confidence interval is

$$t(\phi_e, 0.05)\sqrt{\frac{V_e}{n_e}} = t(3, 0.05)\sqrt{\frac{5}{8}\times 14.3\times 10^{-4}} = 0.095$$

Therefore, the 95% confidence interval of the population mean at $A_1B_1D_1$ is

0.240±0.095 = (0.145, 0.355)

§ 4.4 Additional information about assignment and analysis

(1) Identifying interactive columns on the basis of component symbols

To identify interactive columns, you can use a Fig. annexed to your orthogonal array. Alternatively, you can identify them by using the row of component symbols in the orthogonal array. This can be conducted by using the rule regarding interactive columns:

"Mutually interactive columns are columns having the product of each column of component symbols as component symbols. Provided that, when it comes to results that can be obtained by multiplication, the square of a character, such as a^2, must be equal to 1. This means that $a^2 = b^2 = c^2 = 1$."

Example: In $L_8(2^7)$, identify columns that have an interaction that occurs between columns 3 and 6. Since the component symbol for column 3 is ab and the component symbol for column 6 is bc,

$$ab \times bc = a\,b^2c = ac$$

where the second equation is obtained according to the rule that b1 = 1. Since the column having ac as a component symbol is column 5, the interaction between columns 3 and 6 occurs in column 5.

(2) Assignment using a line-and-dot diagram

The designing of experiments by means of an orthogonal array can be conducted on a trial-and-error basis while looking at the Fig. of interactions between two columns while making sure that factors are assigned to the columns and that the interactive columns are kept empty with no factor assigned to them. At that time, you can assign the interactive factors first as described in Problem 4.2 in §4.3. But assignment can be bothersome depending on the case. To facilitate such assignment, a line-and-dot diagram is available and given as an attached Fig. for each orthogonal array. $L_8(2^7)$, for example, gives two line-and-dot diagrams as shown in Fig. 4.14.

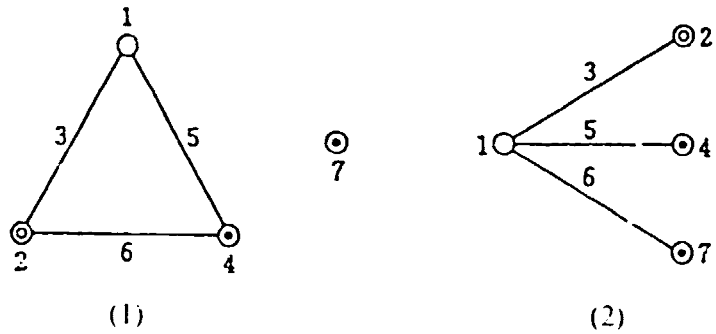


Fig. 4.14 Line-and-dot diagram of $L_8(2^7)$

A line-and-dot diagram is based on the following principles:

(i) It consists of lines and dots. Each of them represents one column. A number is given to each dot and line to indicate which column it represents. Dots come in various types, including ○, ◎, ⊙. The differences among these types can be ignored in this stage.

(ii) A line connecting two dots represents an interaction. For example, Fig. 4.15 indicates that the interaction between columns 1 and 2 occurs in column 3.

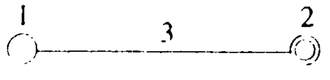


Fig. 4.15 Line-and-dot diagram

The (1) in the line-and-dot diagram of $L_8(2^7)$ comes in handy in experiments designed to check the interactions among the three factors A, B, and C, because the three dots are interconnected by line. To that end, A, B, and C can be assigned to the three dots 1, 2, and 4 (that is, columns 1, 2, and 4). You will then learn that the interactions A x B, B x C, and A x C occur in columns 3, 6, and 5. The (2) in the line-and-dot diagram comes in handy in assigning experiments designed to check the interactions between one factor A and the other three factors B, C, and D, because the one dot and the other three dots are interconnected by line. To that end, one factor can be assigned to column 1, and the other three factors B, C, and D to columns 2, 4, and 7.

A line-and-dot diagram is made by first coming up with various assignments in the orthogonal array and then by classifying and organizing the representative ones into several patterns.

Let me now explain how to make assignments in a line-and-dot diagram, by using a typical problem:

Problem 4.4 Pick up two-level factors A, B, C, D, E, F, G, and H. Assume that the conceivable interactions are A x B, A x C, A x D, A x E, B x C, and F x G and that there are no other interactions. Assign their experiments in a line-and-dot diagram.

Explanation: The factorial effects to be examined consist of eight main effects and six two-factor interactions, 14 in total. Therefore, you need at least 14 columns in your orthogonal array. Think of using $L_{16}(2^{15})$ for assignments.

1°) First, express the factorial effects to be examined, in the form of a line-and-dot diagram. This is called **a required line-and-dot diagram.** It is expressed in dots for factors (main effects) and two-dot-connecting lines for interactions.

In this example, the required line-and-dot diagram takes the form as shown in Fig. 4.16. Since it is assumed that H has no interaction with any other factor, the diagram can be thought to consist of one dot. You do not have to connect it to other dots by line.

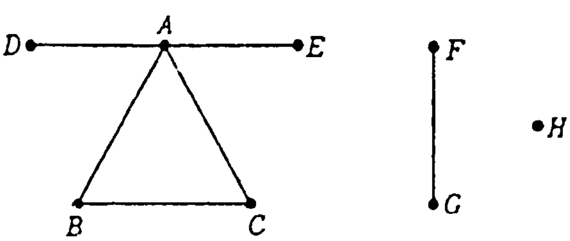


Fig. 4.16 Required line-and-dot diagram

2°) Search the line-and-dot diagram of $L_{16}(2^{15})$ for factors that include part of the required line-and-dot diagram.

Of the six models, models (2) and (3) satisfy these requirements. Here, we will make assignments by using (a) of model (3).

3) Place the required line-and-dot diagrams on a selected line-and-dot diagram. The assignments have now been set. These diagrams can be placed

in only one pattern in some cases and in several patterns in other cases. Pick either of the patterns.

Fig. 4.17 shows two arrangement patterns. Since H does not interact with other factors, you can either place it at the empty dot (column 5) as shown in (1) or on the empty line (column 14) as shown in (2).

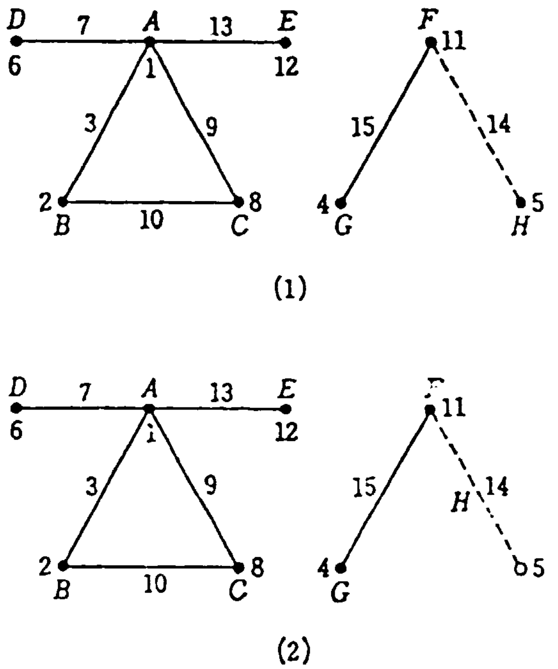


Fig. 4.17 Placing the required line-and-dot diagrams on a line-and-dot diagram

If you place them as shown in (1) in Fig. 4.17, the experiments can be assigned as illustrated in Fig. 4.18.

Fig. 4.18 Assignment Fig.

Column #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Factor	A	B	$A\times B$	G	H	D	$A\times D$	C	$A\times C$	$B\times C$	F	E	$A\times E$		$F\times G$

It is only natural that assignments can be made by using a Fig. of interactions between two columns on a trial-and-error basis without using a line-and-dot diagram. But it would be a little easier to make assignments by using a line-and-dot diagram.

(3) Degrees of freedom and pooling of error terms

One aim of experiments by using an orthogonal array is to reduce the number of experiment replications. Many factors are therefore often assigned to the columns in an orthogonal array. This reduces the number of degrees of freedom of error terms, thus hampering test precision. That is, the errors of class 2 in testing (errors of not giving up the hypothesis even though the hypothesis is wrong) often become greater, resulting in the F test results ending up insignificant.

That is why, in experiments by using an orthogonal array, pooling is often used to increase the freedom of the error terms. This method consists of looking at the row of mean squares and pooling for the error terms the factors that are not much larger than the mean square of the errors. At that time, some people confine the factors to be pooled to interactions, while others do not care which factor to handle.

In some experiments, the error terms have zero degrees of freedom, that is, there are no error terms provided, in order to assign factors to all columns. At that time, some factors having small mean squares are pooled as error terms.

I define pooling as follows: In experiments by using an orthogonal array, where the error terms have few degrees of freedom (there are no error terms in some cases), pooling can safely be used. However, this pooling will not change the relative magnitude of the F_0 value of the factor, so that some factors originally having large F_0 values end up being significant. This, together with the fact that the pooling method cannot be called good or bad in theoretical terms, leads us to the conclusion that you should examine the row of mean squares in the variance analysis Fig. without pooling, regard the factors that have much larger mean squares than the mean squares of the errors as important, and handle them as if they were significant. This would be sufficient in practice, in view of the fact that experiments handling many factors (hence experiments having few degrees of freedom of the errors) do not determine the final optimal requirements and that these experiments are performed in order to select important factors out of the many ones.

§ 4.5 If some of the factors are not of the two-level type

In experiments based on an orthogonal array, all factors must as a rule have the same number of levels. But minor twists can be added to factors that are not of the two-level type so that the latter can be assigned to a two-level orthogonal array.

(1) Assigning four-level factors

Assume that you have picked three factors, A (four-level), B (two-level), and C (two-level), and you wish to assign them on an $L_8(2^7)$ basis. To assign the four-level factor A to a two-level orthogonal array, proceed as follows: When you pick up any pair of columns, for example, columns 1 and 2, the numbers can be arranged in four manners: (1,1), (1,2), (2,1), and (2,2). Make the four levels A_1, A_2, A_1, and A_2 of A to these four numerical arrays. Provided that column 3, where columns 1 and 2 interact, is kept empty with no other factor assigned to it. This means that you are about to assign factors A by using three columns (columns 1, 2, and 3) as illustrated in Fig. 4.19. Letting there be no interaction among A, B, and C, you can assign B and C to either two of the remaining columns: to columns 4 and 7, for example.

Fig. 4.19 Assignment of four-level facters A

Column #			Level of A
(1)	(2)	(3)	
1	1	1	A_1
1	2	2	A_2
2	1	2	A_3
2	2	1	A_4

Fig. 4.20 Assignment Fig.

No. \ Column #	1 (A)	2 (A)	3 (A)	4 (B)	5	6	7 (C)		Level combination
1	1	1	1	1	1	1	1	⟶	$A_1B_1C_1$
2	1	1	1	2	2	2	2	⟶	$A_1B_2C_2$
3	1	2	2	1	1	2	2	⟶	$A_2B_1C_2$
4	1	2	2	2	2	1	1	⟶	$A_2B_2C_1$
5	2	1	2	1	2	1	2	⟶	$A_3B_1C_2$
6	2	1	2	2	1	2	1	⟶	$A_3B_2C_1$
7	2	2	1	1	2	2	1	⟶	$A_4B_1C_1$
8	2	2	1	2	1	1	2	⟶	$A_4B_2C_2$

As a result, the level combinations to be experimented with will be as illustrated in Fig. 4.20.

Let us now examine the orthogonality of factors A, B, and C. Since it is clear that B is orthogonal to C, you can now check the orthogonality of A to B and that of A to C. A close look at the two A_1 experiments, two A_2 experiments, two A_1 experiments, and two A_1 experiments reveals that B_1 and B_2 are once each experimented with, and C_1 and C_2 each once as well. Therefore, the sum of the A_1 data, the sum of the A_2 data, the sum of the A_3

data, and the sum of the A_4 data each contain an equal share of the effects of B and C. On the other hand, a close look at the four B_1 experiments and the four B_2 experiments indicates that each case is experimented once each in terms of A_1, A_2, A_3, and A_4, while the sum of the B_1 data and the sum of the B_2 data each contain an equal share of the effect of A. Similarly, you will learn that the sum of the C_1 data and the sum of the C_2 data also contain an equal share of the effect of A. Consequently, the factors A, B, and C are mutually orthogonal. (If you assign factor B to column 3, B and A are not mutually orthogonal. That is why column 3 is kept empty.)

Since A, B, and C are mutually orthogonal, the data can be analyzed in the same way as previously. The sum S_A of squares between A's, for example, is calculated as follows:

$$S_A = \frac{(\text{Sum of the } A_1 \text{ data})^2}{2} + \cdots + \frac{(\text{Sum of the } A_4 \text{ data})^2}{2} - CT$$

In this case, S_A is equal to the total of the sums of squares of columns 1, 2, and 3. That is,

$$S_A = S_{(1)} + S_{(2)} + S_{(3)}$$

That is why it would be handy to assume that factor A has been assigned to the three columns 1, 2, and 3.

What happens if there is an interaction A x B between the four-level factor A and the two-level factor B? AxB occurs in the three columns to which A is assigned and to the three columns to which B is assigned. That is,

Column to which A is assigned		Column to which B is assigned		
Column (1)	×	Column (4)	=	Column (5)
Column (2)	×	Column (4)	=	Column (6)
Column (3)	×	Column (4)	=	Column (7)

Therefore, A x B occurs in columns 5, 6, and 7. Therefore columns 5, 6, and 7 must be kept empty with no factors assigned to them.

The sum of squares A x B and its number of degrees of freedom can be determined by going through the motions of calculating

$$S_{A \times B} = S_{(5)} + S_{(6)} + S_{(7)}$$
$$\phi_{A \times B} = \phi_{(5)} + \phi_{(6)} + \phi_{(7)} = 1 + 1 + 1 = 3$$

in accordance with the factor that A x B occurs in columns 5, 6, and 7.

(2) Assigning three-level factors with the dummy level process

Assume that factor A is a three-level factor and that its levels are A_1, A_2, and A_3. Since the four-level factors have been successfully assigned to a two-level orthogonal array, create a "dummy level" A_1 and go through the motions of setting A at four levels. As a dummy level A_1, select the level you consider to be important, out of A_1, A_2, and A_3. If, for example, the A_1 level is important, set the level A_1 as the A_1 level. The A_2 level will therefore be experimented with with a frequency twice as large as that of the other A_2 and A_3 levels. Such a level A_2 is called a dummy level. Thus, three-level factors are changed into four-level factors by introducing dummy levels and the method of assigning four-level factors is used.

Fig. 4.21 Assignments including dummy-equipped factors

No. \ Column #	1 (A)	2 (A)	3 (A)	4 (B)	5	6	7	Level combination	Data
1	1	1	1	1	1	1	1	A_1B_1	x_1
2	1	1	1	2	2	2	2	A_1B_2	x_2
3	1	2	2	1	1	2	2	A_2B_1	x_3
4	1	2	2	2	2	1	1	A_2B_2	x_4
5	2	1	2	1	2	1	2	A_3B_1	x_5
6	2	1	2	2	1	2	1	A_3B_2	x_6
7	2	2	1	1	2	2	1	$A_4B_1 = A_2B_1$	x_7
8	2	2	1	2	1	1	2	$A_4B_2 = A_2B_2$	x_8

Let us check if inter-factor orthogonality will be stored if a dummy level is introduced. Consider picking up two factors A (three levels A_1, A_2, and A_3) and B (two levels B_1 and B_2) and assigning them to a two-level orthogonal array $L_8(2^7)$. Since A is of the three-level type, put a dummy $A_1 = A_2$ to change it into a four-level type. Assign A to columns 1, 2, and 3 and B to column 4. As a result, the level combinations to be experimented with will be as illustrated in Fig. 4.21.

Here, a close look at the levels of factor B in experiments with factor A at different levels reveais that

- Two experiments with A_1: B_1 and B_2 once each
- Four experiments with A_2: B_1 and B_2 twice each
- Two experiments with A_3: B_1 and B_2 once each.

A comparison of the average of the A_1 data, the average of the A_2 data, and the average of the A_3 data indicates that each of them has an equal share of the effect of B. This also holds true for factor B: a comparison of the average of the B_1 data with that of the B_2 data reveals that each contains an equal share of the effect of A. The above examination confirmed that factors A and B are mutually orthogonal.

Thus, even though there is a dummy-equipped factor, the experiments still remain mutually orthogonal, so that the experimental data can be analyzed in an ordinary manner. However, the sum of squares of the dummy-equipped factor cannot be formally calculated by means of the sum of squares of column. This calculation must therefore be performed in the original manner. That is, in the present example, the sum S_A of squares among A's is calculated by

$$S_A = \frac{(\text{Sum of the } A_1 \text{ data})^2}{2} + \frac{(\text{Sum of the } A_2 \text{ data})^2}{4}$$

$$+ \frac{(\text{Sum of the } A_3 \text{ data})^2}{2} - CT$$

(not $S_A = S_{(1)} + S_{(2)} + S_{(3)}$).

Therefore, the sum of squares of error is also calculated in the original manner, that is, by means of subtraction from the total of sums of squares

$$Se = S_T - S_A - S_B$$

(not $Se = S_{(5)} + S_{(6)} + S_{(7)}$).

If A and B are mutually interactive, what happens? Since A's are assigned to columns 1, 2, and 3, and B's to column 4, A x B occur in

Column (1)	×	Column (4)	=	Column (5)
Column (2)	×	Column (4)	=	Column (6)
Column (3)	×	Column (4)	=	Column (7)

that is, in three columns: columns 5, 6, and 7. Therefore, these three columns must be kept empty with no factors assigned to them.

Since factor A is equipped with a dummy, you must not go through the motions of defining the sum of squares A x B by $S_{(5)} + S_{(6)} + S_{(7)}$. Instead, you must calculate it in the orthodox way although it is bothersome. That is, first make a two-factor Fig. of A and B (Fig. 4.22).

Fig. 4.22 Two-factor Fig. of A and B

A \ B	B_1	B_2
A_1	x_1	x_2
A_2	$x_3 \cdot x_7$	$x_4 \cdot x_8$
A_3	x_5	x_6

And calculate

$$S_{AB} = \frac{(\text{Sum of the } A_1B_1 \text{ data})^2}{\text{Number of the } A_1B_1 \text{ data}} + \frac{(\text{Sum of the } A_1B_2 \text{ data})^2}{\text{Number of the } A_1B_2 \text{ data}} + \ldots\ldots$$

$$+ \frac{(\text{Sum of the } A_3B_2 \text{ data})^2}{\text{Number of the } A_3B_2 \text{ data}} - CT$$

$$= \frac{x_1^2}{1} + \frac{x_2^2}{1} + \frac{(x_3+x_7)^2}{2} + \frac{(x_4+x_8)^2}{2} + \frac{x_5^2}{1} + \frac{x_6^2}{1} - CT$$

and then calculate

$$S_{A \times B} = S_{AB} - S_A - S_B$$

The freedom $\phi_{A \times B}$ can be calculated by $\phi_{A \times B} = \phi_A \times \phi_B = 2 \times 1 = 2$.

(3) Assigning three-level factors with the combination method

Three-level factors can be assigned to a two-level orthogonal array by combining them with two-level factors whose interaction with them does not need to be determined, instead of by using the dummy method.

Assume that A is a two-level factor, B a three-level factor, and that A x B does not hold. In that case, combine A with B and envisage four-level factors
[AB]

$[AB]_1 = A_1B_1$, $[AB]_2 = A_1B_2$,
$[AB]_3 = A_1B_3$, $[AB]_4 = A_2B_3$

and assign [AB] to three columns with the method of assigning four-level factors. Then, an A_1-A_2 comparison can be determined as a comparison of $[AB]_3$ with $[AB]_4$, and a comparison of B_1, B_2, and B_3 as a comparison of $[AB]_1$, $[AB]_2$, and $[AB]_3$. This means that A and B can be estimated as a partial comparison of the four [AB] levels.

In this example, the use of the dummy level method requires a total of four columns, one for A and three for B. But the combination method requires only three.

In a data analysis, it is to be noted that A and B are not mutually orthogonal. Assume for example that you have additionally picked up two-level factors C and D and assigned them as shown in Fig.s 4.23 and 4.24.

Fig. 4.23 Assignment Fig.

Column #	1	2	3	4	5	6	7
Factor		$[AB]$		C	D		

Fig. 4.24 Level combinations of A and B

Column #			[AB] level
(1)	(2)	(3)	
1	1	1	$[AB]_1 = A_1B_1$
1	2	2	$[AB]_2 = A_1B_2$
2	1	2	$[AB]_3 = A_1B_3$
2	2	1	$[AB]_4 = A_2B_3$

The sum of squares between A's and that of squares between B's can be calculated as follows:

$$S_A = \frac{(\text{Sum of the data at } [AB]_3)^2}{2} + \frac{(\text{Sum of the data at } [AB]_4)^2}{2} - \frac{(\text{Sum of the data at } [AB]_3, [AB]_4)^2}{4}$$

$$S_B = \frac{(\text{Sum of the data at } [AB]_1)^2}{2} + \frac{(\text{Sum of the data at } [AB]_2)^2}{2} + \frac{(\text{Sum of the data at } [AB]_3)^2}{4}$$

$$- \frac{(\text{sum of the data at } [AB]_1, [AB]_2, [AB]_3)^2}{6}$$

On the other hand, the sum of squares between C's, that between D's, and the sum of squares of error can be determined as follows:

$$S_C = S_{(4)},\ S(D) = S_{(5)},\ S_e = S_{(6)} + S_{(7)}$$

Then create a variance analysis Fig. as illustrated in Fig. 4.25 and test it.

Fig. 4.25 Variance analysis Fig.

Cause of fluctuation	Sum of squares		Degree(s) of freedom		Mean square	F_0
$[AB]$	$S_{(AB)}$		3			
A		S_A		1	V_A	V_A/V_e
B		S_B		2	V_B	V_B/V_e
C	S_C		1		V_C	V_C/V_e
D	S_D		1		V_D	V_D/V_e
Error(e)	S_e		2		V_e	
Total(T)	S_T		7			

Here,

$$S_{(AB)} = S_{(1)} + S_{(2)} + S_{(3)}$$

and A is not orthogonal to B. Therefore,

$$S_{(AB)} \neq S_A + S_B$$

$S_{(AB)}$ is calculated here in order to check the calculation of the total of the sums of squares.

As described above, it is possible to design experiments on the basis of a two-level orthogonal array even though factors other than those of the two-level type are present. However, the procedure for handling such a design is a little bothersome. You may therefore want to check if you can use two levels in every case.

If the factors are **quantitative** ones, such as temperature and amount of catalyst, it will probably be somewhat possible to increase or reduce the number of levels. On the other hand, if the factors are qualitative ones, such as material brand and method of operation, it will probably be hard to increase and reduce the number of levels. In the latter case, you should not overambitiously unify the number of levels but should instead use the method mentioned above.

Problem 4.5 Pick up four factors: A (two-level), B(two-level), C(two-level), D (three-level), and E (two-level). And assume that interactions A x B, A x C, and A x D hold. Under these conditions, design experiments by using $L_{16}(2^{15})$.

Explanation: Since factor D is of the three-level type, introduce a dummy and change it into a four-level type. Since, out of the three D levels (D_1, D_2, and D_3), you are interested in D_3, assume that $D_1 = S_2$.

Assignment in a line-and-dot diagram comes in handy when the numbers of levels for each factor are all the same. But, if there is any factor with a different number of levels, it is easier to make assignments while looking at the Fig. of interactive columns without using the line-and-dot diagram (see Note 1 below).

- Assign factor D of the four-level type first. Assign D's to three columns: columns 1, 2, and 3. The arrangement of column numbers for columns 1, 2, and 3, and their correspondence to the D levels must conform to Fig. 4.26.

Fig. 4.26 D assignment

Column #			D level
(1)	(2)	(3)	
1	1	1	$D_4 = D_3$
1	2	2	D_2
2	1	2	D_3
2	2	1	D_1

- Next, assign A's to column 4. The interactions AxD are as shown below:

Column (1) x Column (4) = Column (5)
Column (2) x Column (4) = Column (6)
Column (3) x Column (4) = Column (7)

Therefore, these interactions occur in three columns: columns 5, 6, and 7. Next, assign B's to column 8. A x B occurs in column 12. Then, assign C's to column 9 to find that A x C occurs in column 13. Since E does not interact with other factors, you can assign it to any empty column. Assuming that E has been assigned to column 15, you will find the assignment Fig. as illustrated in Fig. 4.27.

Fig. 4.27 Assignment Fig.

Column #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Factor		D		A		$A \times D$		B	C			$A \times B$	$A \times C$		E

The level combinations of factors for 16 experiments with the above assignments are as shown below.

No. 1: $A_1B_1C_1D_2E_1$. No.2: $A_1B_2C_2D_2E_2$ ....,
No. 16: $A_2B_2C_1D_1E_1$

And you will perform these 16 experiments in a random order. (For an analysis of the experimental data, see Problem 4.2.)

Note 1: The line-and-dot diagram required for the assignments in Problem 4.5 will become something like Fig. 4.28. You cannot place this required line-and-dot diagram on an available line-and-dot diagram without some twist. Thus, the use of a line-and-dot diagram in assignments provides some difficulties. This document therefore is not based on assignment based on a line-and-dot diagram. Section 4.6 handles assignments based on a line-and-dot diagram, but this is from a slightly different viewpoint. What is more, the available line-and-dot diagram is different from the one illustrated in Section 4.4.

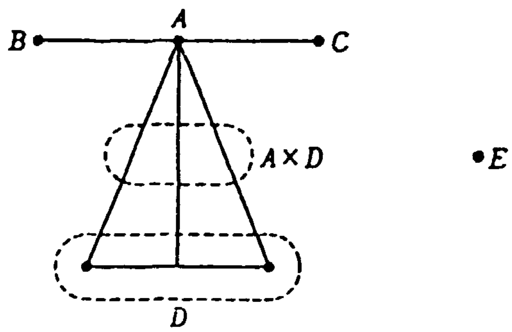


Fig. 4.28 Required line-and-dot diagram

Problem 4.6 To prevent external wall tiles from coming off, you want to find installation conditions that will increase the adhesiveness of the structure (concrete) and the priming mortar. As factors, you have picked the types of structure adhesive A (A_1, A_2, A_3), the coating density of the structure adhesive B (B_1, double; B_2, quadruple), the mortar adhesive C (C_1, to be added; C_2, not to be added), and the mortar mix ratio D (D_1, 1:2; D_2, 1:3). Since factor A is of the three-level type, you have introduced a dummy and changed it into a four-level type and performed experiments with the factors assigned to the orthogonal array $L_8(2^7)$ as illustrated in Fig.s 4.29 and 4.30. You have taken two adhesiveness measurements under each experimental condition and obtained the results summarized in Fig. 4.31. Analyze these data. Note that the standard adhesiveness is 6kg/ mm2 or above.

Fig. 4.29 Assignment Fig.

Column #	1	2	3	4	5	6	7
Factor		$\underbrace{\quad\quad}_{A}$		B		C	D

Fig. 4.30 Assignments of A

Column # (1)	(2)	(3)	Level of A
1	1	1	A_1
1	2	2	A_2
2	1	2	A_3
2	2	1	$A_4=A_1$

Fig. 4.31 Experimental data

No.	Level combination	Adhesiveness x_{ij} (kg/cm²)		Value after conversion u_{ij}		Total
1	$A_1B_1C_1D_1$	17.8	19.2	−22	−8	−30
2	$A_1B_2C_2D_2$	19.7	18.6	−3	−14	−17
3	$A_2B_1C_2D_2$	25.6	22.7	56	27	83
4	$A_2B_2C_1D_1$	17.4	18.6	−26	−14	−40
5	$A_3B_1C_1D_2$	28.1	26.8	81	68	149
6	$A_3B_2C_2D_1$	29.4	26.9	94	69	163
7	$A_1B_1C_2D_1$	22.3	24.3	23	43	66
8	$A_1B_2C_1D_2$	12.5	13.6	−75	−64	−139
			Total	128	107	235

Explanation: Based on the assignment Fig., assume that the total of the sums of squares can be broken down into

$$S_T = S_A + S_B + S_C + S_D + S_{e1} + S_{e2}$$

Since two measurements have been taken under each condition, the sum of squares of error can be determined by dividing it into the sum of squares of primary errors (S_{e1}) corresponding to the experimental error and the sum of squares of secondary errors (S_{e2}) corresponding to the measured errors.

Converting the data into

$$u_{ij} = (x_{ij} - 20.0) \times 10$$

yields the result as indicated in Fig. 4.31. This leads to:

$$CT' = \frac{(235)^2}{16} = 3451.6$$

$$S'_T = (-22)^2 + (-8)^2 + \cdots + (-64)^2 - 3451.6 = 38919.4$$

$$S'_{T_1} = \frac{(-30)^2}{2} + \frac{(-17)^2}{2} + \cdots + \frac{(-139)^2}{2} - 3451.6 = 37610.9$$

$$S'_{e_2} = S'_T - S'_{T_1} = 1308.5$$

$$S'_A = \frac{[(-30)+(-17)+(66)+(-139)]^2}{8} + \frac{[(83)+(-40)]^2}{4}$$

$$+ \frac{[(149)+(163)]^2}{4} - 3451.6 = 23146.7$$

$$S'_B = S'_{(4)} = \frac{[(-30)+(83)+(149)+(66)]^2}{8}$$

$$+ \frac{[(-17)+(-40)+(163)+(-139)]^2}{8} - 3451.6$$

$$= 5662.5$$

$$S'_C = S'_{(6)} = \frac{[(-30)+(-40)+(149)+(-139)]^2}{8}$$

$$+ \frac{[(-17)+(83)+(163)+(66)]^2}{8} - 3451.6 = 7876.5$$

$$S'_D = S'_{(7)} = \frac{[(-30)+(-40)+(163)+(66)]^2}{8}$$

$$+ \frac{[(-17)+(83)+(149)+(-139)]^2}{8} - 3451.6 = 430.5$$

From this, you will obtain a variance analysis Fig. as illustrated in Fig. 4.32. Since the primary error is not significant, you will pool the primary error to the secondary one and you will get a variance analysis Fig. as indicated in Fig. 4.33. This Fig. indicates that A, B, and C are 1% significant and that D is insignificant.

Fig. 4.32 Variance analysis Fig. for Problem 4.6

Cause of fluctuation	Sum of squares	Degree(s) of freedom	Mean square	Fo
Type of adhesive (A)	231.467	2	115.734	
Coating density (B)	56.625	1	56.625	
Mortar adhesive(C)	78.765	1	78.765	
Mortar mix ratio(D)	4.305	1	4.305	
Primary error (e 1)	4.947	2	2.474	1.5
Secondary error (e 2)	13.085	8	1.636	
Total(T)	389.194	15		

Fig. 4.33 Variance analysis Fig. after pooling (Problem 4.5)

Cause of fluctuation	Sum of squares	Degree(s) of freedom	Mean square	Fo
Type of adhesive (A)	231.467	2	115.734	64.2**
Coating density (B)	56.625	1	56.625	31.4**
Mortar adhesive(C)	78.765	1	78.765	43.7**
Mortar mix ratio(D)	4.305	1	4.305	2.4
Secondary error ($e'2$)	18.032	10	1.803	
Total(T)	389.194	15		

Note 2: Since the number of measurements is 2 in this problem, you can also use the range to calculate the sum of squares of secondary errors.

$$S'_{e_1} = \frac{1}{2}\sum_i R_i^2 = \frac{1}{2}[(14)^2+(11)^2+\cdots+(11)^2] = 1308.5$$

If you estimate the level effects regarding the significant factors A, B, and C, the optimal level combination (or the optimal installation condition) will be $A_1B_1C_1$. Since factor D is not significant, you can adopt either D_1 or D_2.

Let us determine the dot estimate of the population mean of adhesiveness values when the installation condition $A_1B_1C_1$ is adopted, along with the 95% confidence interval.

Since

$$\begin{aligned}\mu(A_3B_1C_2) &= \mu + \alpha_3 + \beta_1 + \gamma_2 \\ &= (\mu + \alpha_3) + (\mu + \beta_1) + (\mu + \gamma_2) - 2\mu\end{aligned}$$

the dot estimate is

$\hat{\mu}(A_3B_1C_2)$ = (average of the A_3 data) + (average of the B_1 data)
+ (average of the C_2 data) - 2(average of all the data)

= 27.80 + 23.35 + 23.69 - 2 x 21.47 = 31.90

Since the effective number of replications of this estimate is

$$\frac{1}{n_e} = \frac{1}{4} + \frac{1}{8} + \frac{1}{8} - \frac{2}{16} = \frac{3}{8}$$

the 95% confidence interval is

$$31.90 \pm t(10, 0.05)\sqrt{\frac{3}{8} \times 1.803} = (30.07,\ 33.73)$$

The 95% confidence interval of the individual adhesiveness values when the installation condition $A_3B_1C_2$ is adopted becomes:

$$31.90 \pm t(10, 0.05)\sqrt{\left(1+\frac{3}{8}\right)\times 1.803} = (28.40,\ 35.40)$$

Since the standard adhesiveness is 6kg/cm^2 or above, you may think that the installation condition $A_3B_2C_1$ satisfies the standard fully.

We have just checked the adhesiveness of the optimal installation condition alone. Similar estimates should probably be made of the optimal installation conditions $A_1B_1C_1$ and $A_2B_2C_2$ when A is A_1 and A_2. It should also be necessary to identify all the installation conditions that satisfy the standard and choose the best one from the viewpoint of both adhesiveness and ease of installation.

§ 4.6 Introducing block factors

The previous discussion was on the basis that all experiments are performed in a random order under equal environmental conditions (experimental conditions). However, you must spend several days on completing all experiments, not all at once. What would you do if the experimental conditions change slightly depending on the day? Ignoring the fact that the experiments are performed on different days and performing all of them in a random order would result in the differences in days being included in the experimental errors, which will become larger and aggravate the experimental precision. Then, under what standard should we divide the experiments to perform them on different days? This section will give the solution to such problems.

If all experiments cannot be experimented with under equal conditions, you will introduce blocks (factors) and identify differences in environmental conditions separately as the sum of squares between blocks. A block is a place where you can perform experiments under equal conditions. Block factors include days, apparatus, lots of materials, and operators.

If the number of experiments possible under equal conditions is 4 in the $L_8(2^7)$ experiments, 8 divided by 4 equals 2. Therefore, you can introduce the block factor R of the two-level type. You can then regard this R as one factor of the two-level type and assign it to an empty column in an orthogonal array. If you assign the R to column 7, the experiment numbers to be performed in each block will be:

- Experiments in block 1 (R_1): Nos. 1, 4, 6, and 7
- Experiments in block 2 (R_2): Nos. 2, 3, 5, and 8.

And you will perform the four experiments in each block in a random order. If you do so, the factorial effect and the block effect will become mutually orthogonal because of the nature of the orthogonal array, so that the factorial effect can be estimated without being affected by the block. In analyzing the experimental data, you can determine the sum of squares between blocks (S_R) by

$$S_R = S_{(7)}.$$

Next, if the number of experiments possible under equal conditions is 2 in $L_8(2^7)$ experiments, 8 divided by 2 equals 4. Therefore you will introduce a four-level block factor. As described in Section 4.5, four-level factors can be assigned to a two-level orthogonal array. You will then assign R accordingly. The sum of squares between blocks (S_R) can be calculated as the total of the sums of squares of columns to which block R is assigned.

The same concept can be used to introduce block factors in other orthogonal arrays.

Exercises

4.1 Pick up three-level factors A and B and two-level factors C, D, E, F, G, H, and I, and think of interactions E x G, E x H, and G x I.

Under these conditions, design experiments by using $L_{16}(2^{15})$. Since you will use two items of apparatus for these experiments, you need to divide the 16 experiments into two groups, each consisting of 8 experiments.

4.2 Assume that, in the experiments in Problem 4.5, you have obtained experimental data as shown in the Fig. below. The larger the data, the better they are.

(1) Conduct an analysis of variances and determine the optimal level combination.

(2) Estimate the population mean in the optimal level combination determined in (1).

No.	Data	No.	Data	No.	Data	No.	Data
1	64	5	69	9	64	13	66
2	63	6	62	10	60	14	59
3	54	7	58	11	56	15	74
4	56	8	48	12	46	16	64

4.3 To determine the sum of squares of primary errors (S_{e1} = 4.947) in Problem 4.6, you may use the following formula:

$$S_{e1} = S(5) + \frac{[(\text{Sum of the data at the } A_1 \text{ level}) - (\text{Sum of the data at the } A_4 \text{ level})]^2}{8}$$

(1) Use Equation (*)to determine S_{e1}.
(2) What does Equation (*) mean?

Chapter 5
Design of Experiments Based on an Orthogonal Array
- A Three-Level Array -

If the factors you have picked up are all of the three-level type, you will use a three-level orthogonal array. This chapter shows you how to design experiments by using a three-ievel orthogonal array. The concepts and methods of this array are similar to
those of a two-level array. I will therefore focus on the points that differ from those of the two-level array.

§5.1 Three-level orthogonal array

Fig. 5.1 indicates $L_{27}(3^{13})$, one of the three-level orthogonal arrays. This is called "three-level" because the Fig. gives three types of number: 1, 2, and 3. It is called "orthogonal" because the Fig. has the following characteristic:

Characteristic of a three-level orthogonal array: When you pick up any two columns, the numbers can be arranged in nine manners:
(1,1), (1,2) (1,3) (2,1) (2,2) (2,3) (3,1) (3,2) (3,3).

Whichever two columns you may take, each of these nine arrays is sure to appear the same number of times.

Let us confirm this characteristic by using $L_{27}(3^{13})$. Take columns 1 and 4 as two columns. The numbers are arranged in descending order: (1,1), (1,1),(1,1),(1,2),(1,2),(1,2) ,...,(3,1),(3,1),(3,1). Each of the numerical arrays will appear three times, like (1,1) three times, (1,2) three
times, and so on. This characteristic holds true whichever two columns you may take.

Fig. 5.1 Orthogonal array $L_{27}(3^{13})$

No. \ Column #	1	2	3	4	5	6	7	8	9	10	11	12	13
1	1	1	1	1	1	1	1	1	1	1	1	1	1
2	1	1	1	1	2	2	2	2	2	2	2	2	2
3	1	1	1	1	3	3	3	3	3	3	3	3	3
4	1	2	2	2	1	1	1	2	2	2	3	3	3
5	1	2	2	2	2	2	2	3	3	3	1	1	1
6	1	2	2	2	3	3	3	1	1	1	2	2	2
7	1	3	3	3	1	1	1	3	3	3	2	2	2
8	1	3	3	3	2	2	2	1	1	1	3	3	3
9	1	3	3	3	3	3	3	2	2	2	1	1	1
10	2	1	2	3	1	2	3	1	2	3	1	2	3
11	2	1	2	3	2	3	1	2	3	1	2	3	1
12	2	1	2	3	3	1	2	3	1	2	3	1	2
13	2	2	3	1	1	2	3	2	3	1	3	1	2
14	2	2	3	1	2	3	1	3	1	2	1	2	3
15	2	2	3	1	3	1	2	1	2	3	2	3	1
16	2	3	1	2	1	2	3	3	1	2	2	3	1
17	2	3	1	2	2	3	1	1	2	3	3	1	2
18	2	3	1	2	3	1	2	2	3	1	1	2	3
19	3	1	3	2	1	3	2	1	3	2	1	3	2
20	3	1	3	2	2	1	3	2	1	3	2	1	3
21	3	1	3	2	3	2	1	3	2	1	3	2	1
22	3	2	1	3	1	3	2	2	1	3	3	2	1
23	3	2	1	3	2	1	3	3	2	1	1	3	2
24	3	2	1	3	3	2	1	1	3	2	2	1	3
25	3	3	2	1	1	3	2	3	2	1	2	1	3
26	3	3	2	1	2	1	3	1	3	2	3	2	1
27	3	3	2	1	3	2	1	2	1	3	1	3	2
Component symbol	a	b	a b	a b^2	c	a c	a c^2	b c	a b c	a b^2 c^2	b c^2	a b^2 c	a b c^2
Group #	1	2			3								

The three-level orthogonal arrays other than the one shown in Fig. 5.1 are $L_9(3^4)$ and $L_{81}(3^{40})$ (Attached Fig. 5).

Note: In a three-level orthogonal array,

$$(\text{Number of columns}) = \frac{1}{2}\{\ (\text{number of rows}) - 1\ \}.$$

Here, determining the number of rows automatically determines the number of columns. That is why $L_{27}(3^{13})$, for example, is called a three-level orthogonal array with a magnitude of 27 because the number of columns (13) does not need mentioning.

§5.2 If there is no interaction among the factors

This section shows you how to assign experiments in a three-level orthogonal array and analyze the data when the factors you have picked up are all of the three-level type and there is no interaction among the factors.

Experiments are assigned here in exactly the same way as in a two-level orthogonal array. That is,
1°) The factors are assigned to any columns in an orthogonal array.
2°) The numbers 1, 2, and 3 of the columns to which the factors are assigned determine the level combinations of the columns in each experiment number.
3°) All experiments are performed in a random order.

Experimental data can be analyzed in the same way as in factorial experiments, because the factors are mutually orthogonal. That is, the sum of squares of each factor (the sum of squares among A's for example) can be determined as follows:

$$S_A = \frac{(\text{sum of the } A_1 \text{ data})^2}{\text{number of the } A_1 \text{ data items}} + \frac{(\text{sum of the } A_2 \text{ data})^2}{\text{number of the } A_2 \text{ data items}} + \frac{(\text{sum of the } A_3 \text{ data})^2}{\text{number of the } A_3 \text{ data items}} - CT$$

The sum of squares of error can be calculated by subtracting it from the total of the sums of squares.

In the same way as in a two-level orthogonal array, the sum of squares of column can be used to determine the sum of squares of each factor. In a three-level orthogonal array, the sum of squares of column i is determined as follows:

$$S_{(i)} = \frac{(\text{sum of the data where column } i \text{ is } 1)^2}{\text{number of the data items where column } i \text{ is } 1}$$

$$+ \frac{(\text{sum of the data where column } i \text{ is } 2)^2}{\text{number of the data items where column } i \text{ is } 2}$$

$$+ \frac{(\text{sum of the data where column } i \text{ is } 3)^2}{\text{number of the data items where column } i \text{ is } 3} - CT$$

And assume that the sum of squares of one column has one degree of freedom. Just like in a two-level orthogonal array, the total of the sums of squares of each column is equal to the total of the sums of squares.

§5.3 If there is an interaction among the factors

The preceding section was based on the assumption that the factors you had picked up were not mutually interactive. Then, what happens if they are mutually interactive? In a two-level orthogonal array, the interaction between two factors occurred in one column. In a three-level orthogonal array, the interaction between two factors occurs in two columns. This will make sense to you when you think that, in a three-level orthogonal array, one column has two degrees of freedom and that the interaction among the three-level factors has four degrees of freedom.

In which column the interactions among the factors assigned to two columns occur is indicated in the Fig. of interactions between two columns attached to the orthogonal array. In $L_{27}(3^{13})$, for example, the interaction between columns 4 and 7 occur in columns 9 and 11.

When the factors are mutually interactive, experiments can be assigned similarly to the case of a two-level orthogonal array: you can make sure that the interactive columns are kept empty with no factor or other factorial effect assigned to them and
assign the factors to columns.

The sum of squares of interactions can be calculated in the same way as previously. That is, if an interaction A x B holds, you can calculate

$$S_{AB} = \frac{(\text{sum of the } A_1B_1 \text{ data})^2}{\text{number of the } A_1B_1 \text{ data items}} + \frac{(\text{sum of the } A_1B_2 \text{ data})^2}{\text{number of the } A_1B_2 \text{ data items}}$$

$$+ \cdots\cdots + \frac{(\text{sum of the } A_3B_3 \text{ data})^2}{\text{number of the } A_3B_3 \text{ data items}} - CT$$

and calculate

$$S_{A \times B} = S_{AB} - S_A - S_B$$

Another method is by the sum of squares of column. This method consists of calculating the sum of squares of interaction as the total of the sums of squares of two columns where those interactions occur.

Problem 5.1 Pick up three-level factors A, B, C, D, and E and assume that interactions A x B and A x C are likely to hold and that all other interactions are negligible. Under these conditions, design experiments by using an orthogonal array.

Explanation: Since the factors are of the three-level type, use a three-level orthogonal array. Since there are five factors and two interactions between two factors, you will need a total of nine columns. Therefore consider making assignments by using $L_{27}(3^{13})$.

In this assignment, start with the interactive factors. Assign A to column 1 and B to column 2 and you will find A x B occurring in columns 3 and 4. Therefore keep columns 3 and 4 empty with no factors assigned to them. Then assign C to column 5 and you will find A x C occurring in columns 6 and 7. Therefore keep columns 6 and 7 empty with no factors assigned to them. Since the remaining factors D and E are not interactive with other factors, you can assign them to any of the remaining columns. Let us now assume that you are assigning D to column 12 and E to column 13. As a result, the assignments will be made as shown in Fig. 5.2.

Fig. 5.2 Assignment Fig.

Column #	1	2	3	4	5	6	7	8	9	10	11	12	13
Factor	A	B	AxB	AxB	C	AxC	AxC					D	E

The level combinations of experiments will be as follows:
No.1: $A_1B_1C_1D_1E_1$, No.2: $A_1B_1C_2D_2E_2$, ..., No. 27: $A_3B_3C_3D_3E_3$. You will perform these 17 experiments in a random order.
The total of the sums of squares will be broken down into

$$S_T = S_A + S_B + S_C + S_D + S_E + S_{A \times B} + S_{A \times C} + S_e$$

and the sum of each set of squares can be calculated as follows by using the sum of squares of column:

$$S_A = S_{(1)},\ S_B = S_{(2)},\ S_C = S_{(5)},$$
$$S_D = S_{(12)},\ S_E = S_{(13)},$$

$S_{A\times B} = S_{(3)} + S_{(4)}$, $S_{A\times C} = S_{(6)} + S_{(7)}$,
$S_e = S_{(8)} + S_{(9)} + S_{(10)} + S_{(11)}$

Here, it may be well-advised to check the calculations of the sum of squares of column by using the relationship

S_T = (sum of squares of each data item) - CT
$= S_{(1)} + S_{(2)} + \ldots\ldots S_{(13)}$

Since the freedom rules specify 2 degrees of freedom or one column has two degrees of freedom, the freedom of the sum of each set of squares will be:

$\phi_T = 26$, $\phi_A = \phi_B = \phi_C = \phi_D = \phi_E = 2$,
$\phi_{A\times B} = \phi_{A\times C} = 4$, $\phi_e = 8$

Identifying the interactive columns on the basis of component symbols:

The interactive columns can also be identified by using the row of component symbols in an orthogonal array. This can be accomplished by using the following rule regarding interactive columns:

"Interactions between two columns are columns having as a component symbol the product of the component symbols of each column. Provided that the square of a component symbol should be regarded as equal to the original component symbol. Therefore, when multiplying a component symbol, the square of either of the two must be multiplied. The two columns having as a component symbol the product of the two thus obtained are the columns where an interaction between the two columns occurs. However, in performing a multiplication, the cube of a character must be equal to 1 as a^3, hence $a^3 = b^3 = c^3 = 1$."

Example: In $L_{27}(3^{13})$, identify the columns where the interaction between columns 4 and 9 occurs.

Column 4 x column 9
$ab^2 \times abc = a^2b^3c = a^2c = (a^2c)2$
$= a^4c^2 = ac^2 \longrightarrow$ Column 7
$ab^2 \times (abc)^2 = a^3b^4c^2 = bc^2 \longrightarrow$ Column 11

Therefore, the interaction between columns 4 and 9 occurs in columns 7 and 11. If no column has as a component symbol the product of two factors, you can determine the square of that component symbol.

Assignment by using a line-and-dot diagram
A line-and-dot diagram is available to facilitate assignment just like in a two-level diagram. One example of $L_{27}(3^{13})$ line-and-dot diagram is illustrated in Fig. 5.3. Since the interaction between two columns occurs in two columns in the case of a three-level diagram, two numbers are written beside the line representing the interaction between the two columns.

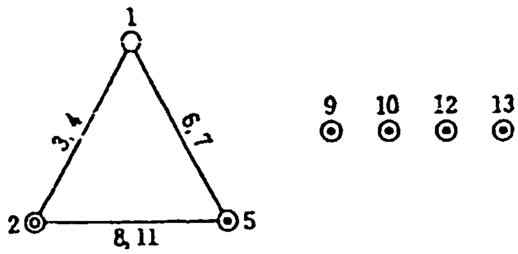


Fig. 5.3 $L_{27}(3^{13})$ line-and-dot diagram

Factors are assigned in a line-and-dot diagram in exactly the same way as in a two-level diagram. That is, you can draw a required line-and-dot diagram and place it on an available line-and-dot diagram.

§5.4 If there is a factor not of the three-level type

Even if there is a factor not of the three-level type, you can assign it to a three-level orthogonal array by adding a twist.

(1) Assigning nine-level factors

A nine-level factor A can be assigned to a three-level orthogonal array as follows: Pick up any two columns and you will find the numbers arranged in nine manners: (1,1), (1,2), (1,3), (2,1), (2,2), (2,3), (3,1), (3,2), and (3,3). Assign the nine levels A_1 through A_9 of A to these nine numerical arrays. But do not assign any other factor to the two columns where the interaction between the two columns occurs, thus keeping them empty. This means that any two columns and two columns where their interaction occurs (four columns in total) can be used
to assign nine-level factors of A.

The sum of squares among A's can be calculated either by

$$S_A = \frac{(\text{Sum of the } A_1 \text{ data})^2}{\text{Number of the } A_1 \text{ data items}} + \cdots + \frac{(\text{Sum of the } A_9 \text{ data})^2}{\text{Number of the } A_9 \text{ data items}}$$

or by

S_A = [Sum of the sums of squares of columns to which factor A is assigned].

The interaction A x B between the nine level factors of A and the three-level factors of B occurs in the eight columns where the four A-assigned columns interact with the B-assigned columns. Assume that factor A is assigned to columns 1, 2, 3, and 4 in $L_{27}(3^{13})$, for example. Then, A x B will occur in a total of eight columns: columns 6, 7, 8, 11, 9, 13, 10, and 12.

(2) Assigning two level factors with the dummy level method

To assign a two-level factor C to a three-level orthogonal array, you can install a dummy in C and change it into a three-level type. That is, you will change C into a third level (C_3) and pick up the most important one from C_1 and C_2. If C_2 is important
and you are interested in it, let $C_1 = C_2$.

Since the sum SC of squares of factor C with a dummy in it cannot be formally calculated by the sum of squares of column, you must calculate it by

$$Sc = \frac{(\text{Sum of the } C_1 \text{ data})^2}{n} + \frac{(\text{Sum of the } C_2 \text{ data})^2}{2n} - CT$$

(n is the number of the C1 data items and $n = 9$ in the case of $L_{27}(3^{13})$).

Since, accordingly, you cannot calculate the sum of squares of error as the total of the sums of squares of the empty columns in a formal manner, you will calculate it by subtracting it from the total of the sums of squares.

(3) Assigning two-level factors with the combination method

Two-level factors can be assigned to a three-level orthogonal array by combining two factors of the two-level type having no interaction between them, instead of using the dummy level method.

Assume that A and B are two-level factors and that A x B does not hold. In this case, combine A with B and think of three-level factor [AB] as in

$[AB]_1 = A_1B_1$, $[AB]_2 = A_2B_1$, $[AB]_3 = A_2B_2$

and assign the factors [AB] to one column. Then, you will be able to compare A_1 with A_2 as a comparison of $[AB]_1$ with $[AB]_2$ and to compare B_1 with B_2 as a comparison of $[AB]_1$ with $[AB]_2$.

The data can be analyzed in the same way as in the combination method (3) of Section 4.5) in the case of a two-level orthogonal array.

§5.5 Introducing block factors

The concept behind introducing block factors is the same as in a two-level orthogonal array (Section 4.6).

If, in experiments with $L_{27}(3^{13})$, nine experiments can be performed under equal conditions, you can introduce the three-factor block factor R because 27 divided by 9 is 3. To that end, you will regard R as one three-level factor and assign the R to an empty column in the orthogonal array. Assuming that you have assigned the R to column 13, you will find the experiment numbers to be performed in each block as follows:

- Experiments in block 1 (R_1): 1, 5, 9, 11, 15, 16, 21, 22, 26
- Experiments in block 2 (R_2): 2, 6, 7, 12, 13, 17, 19, 23, 27
- Experiments in block 3 (R_3): 3, 4, 8, 10, 14, 18, 20, 24, 25.

And the nine experiments in each block will be performed in a random order. If you proceed this way, the factorial effect will become orthogonal to the block effect because of the nature of the orthogonal array. In analyzing the experimental data, you can determine the sum Sn of squares between blocks as follows:

$$S_R = S_{(13)}.$$

Next, in experiments with L(3), if three experiments can be performed under equal conditions, you can introduce the nine-level block factor R as explained in Section 5.4. Since a nine-level factor has successfully been assigned to a three-level orthogonal array, it is possible here as well. The sum SR of squares between blocks is calculated as the total of the sums of squares of columns to which block R is assigned. If, for example, you have assigned R to columns 1, 2, 3, and 4,

$$S_R = S_{(1)} + S_{(2)} + S_{(3)} + S_{(4)}.$$

Exercises

5.1 To increase the strength of a plastic part, you have picked up a total of five factors: material A (two-level), molding condition B (two-level), C (three-level), D (two-level), and E (three-level). Here, consider performing experiments with L(3) by
using the dummy level method and the combination method.

Let A be a three-level type with a dummy. But let $A_3 = A_1$.

Combine B with D and consider a three-level factor [BD].

But let $[BD]_1 = B_1D_1$, $[BD]_2 = B_2D_1$, $[BD]_3 = B_2D_2$.

Finally, you have assigned the factors to L(3) as shown in the Fig. below and performed nine experiments in a random order.

Assignment Fig.

Column #	1	2	3	4
Factor	A	[BD]	C	E

You have obtained strength measurements as shown in the Fig. below. Under each experimental condition, you have obtained two data items. Analyze these data items.

Strength

No.	Data	
1	40.0	41.2
2	39.2	41.6
3	44.7	42.5
4	41.1	41.9
5	48.6	47.2
6	42.0	41.8
7	44.3	44.1
8	38.8	40.6
9	39.3	38.5

Chapter 6
Precautions to Be Taken When Applying the Design of Experiment

The preceding chapters have described how to design experiments and analyze experimental data on the assumption that all target characteristics, factors, levels, and other elements you will pick up are fixed.

This chapter describes issues arising from the use of the design of experiments, such as how to choose characteristics, factors, and levels, partly by way of a summary of this document.

§6.1 Choosing characteristics and analyzing data

The preceding problems used strength, yield, and other measurements as characteristics. That is, these problems handled only the characteristics that can be considered to follow normal distribution. This is because the method of data analysis in this document is based on a theory based on the premise that data follows normal distribution.

But, in actual practice, a characteristic is often not a measurement. Let me cite some examples of cases often encountered.

Example 1: When article quality is expressed as good or poor, m articles are manufactured under each experimental condition (each level combination of experiments) and the number (r) of the defectives checked. In this case, the conceivable characteristics are the number of defectives (r) and the percentage defective $\frac{r}{m}$ x 100(%).

Example 2: When article quality is expressed in the number of defects contained, m articles are manufactured under each experimental condition and the total number of defects (c) in the m articles is checked. In this case, the conceivable characteristics are the number of defects (c) and the average number of defects per article $\frac{c}{m}$.

Example 3: In Example 2, the defects are stratified into some strata and the number of defects per stratum checked. If, for example, the defects are divided into major, medium, and minor defects and there are two major defects, three medium defects, and seven minor defects, the data can be expressed as shown in Fig. 6.1. This is one item of experimental data. In that case, how should we take characteristics?

Fig. 6.1 Experimental data

Major defects	Medium defects	Minor defects
2	3	7

Example 4: (i) If the articles are graded as first, second, and third-grade, m articles are manufactured under each experimental condition and the number of first-grade articles, that of second-grade articles, and that of third-grade articles are checked. Assuming, for example, that 30 articles comprise 24 first-grade articles, four second-grade articles, and two third-grade articles. the data can be expressed as illustrated in Fig. 6.2.

(ii) When the articles manufactured under each experimental condition are shown to 20 people for identification of superior, medium, and inferior quality, the experimental data can be expressed as shown in Fig. 6.3.

Fig. 6.2 Experimental data

First grade	Second grade	Third grade	Total
24	4	2	30(=m)

Fig. 6.3 Experimental data

Superior	Medium	Inferior	Total
13	5	2	20(=m)

The data indicated in Fig.s 6.2 and 6.3 each represent one item of experimental data. In this case, how should we take characteristics?

Although the data in Example 3 look similar to those in Example 4, it must be noted that they have quite different characteristics. Example 4 is characterized by the fact that "Under any experimental condition, the sum of the first, second, and third-grade articles is always m."

Experimental data are analyzed by making a variance analysis Fig. and testing various hypotheses by means of F distribution. The mathematical theory that F distribution can be used for testing is based on the hypothesis that data follows normal distribution. Remember that the data model previously mentioned assumes that "errors follow normal distribution." On the other hand, it is known that, even if data do not follow normal distribution, an F distribution test does not make such a big difference.

In this connection, I would like to point out that the row of expected mean squares in a variance analysis Fig. is brought about without the hypothesis that the data follow normal distribution. It is therefore nor quite absurd to decide whether to reject a hypothesis according to the magnitude of the F value regardless of regularity hypotheses.

This leads to the conclusion that, in practice, if a characteristic is expressed in a value, that value can be used as data for variance analysis even if the value does not follow normal distribution. From this viewpoint, analyses can be made by using the number of defects or percentage defective as a characteristic in Example 1, and by using the number of defects or average number of defects as a characteristic in Example 2.

Since the characteristic in Example 3 and 4 does not constitute one value, it cannot be subjected to a variance analysis without some twist. One method, in Example 4, is to score the first, second, and third-grade articles appropriately, like the first-grade articles as 5 points, the second-grade articles as 3 points, and the third-grade articles as 1 point, and then adopting the total score as a characteristic. A similar method, in Example 3, is to assign penalties to major, medium, and minor defects and then adopt the total penalty score as a characteristic. The latter method is not recommendable, because it entails the tough challenge as to how to score first, second, and third-grade articles.

As an alternative to assigning values to each stratum, the following method is conceivable: In Example 3, this method consists of:
(1) conducting a variance analysis by using the number of major defects as a characteristic, (2) conducting a variance analysis by using the sum of the number of major defects and the number of medium defects as a characteristic, and (3) conducting a variance analysis by using the sum of the number of major defects, that of medium defects, and that of minor defects (that is, the total number of defects) as a characteristic. In Example 4, this method consists of conducting a variance analysis by using (1) the number of first-grade articles, (2) the sum of the number of first-grade articles and that of second-grade articles (that is, the number of first and second-grade articles, as a characteristic.

This method produces more than one variance analysis Fig., thus raising a challenge: how should we integrate these findings and draw a conclusion? One appropriate solution would be to think of the objective of your experiment and adopt either finding accordingly. In Example 3, for example, if your immediate goal is to reduce the number of medium and major defects, you should emphasize the analysis result (2).

As an analytic method for Example 3 and 4, Genichi Taguchi advocates the cumulative method (Reference 3). His method leads to one variance analysis Fig..

From another viewpoint related to the theory of variance analysis, it is considered desirable that, in Examples 1 and 2, the data should first be converted as shown below and used for variance analysis, instead of using the raw data. In Example 1,

$\frac{r}{m}$ is converted into x by

$$x = \sin^{-1}\sqrt{\frac{r}{m}} \qquad (6.1)$$

and the x is used as a characteristic. The conversion shown in Equation 6.1 is called an inverse sine transformation or angular transformation. The numerical Fig. for this conversion is given in Reference 5. In Example 2, c is converted into x by

$$x = \sqrt{c}$$

and the x is used as a characteristic.

§6.2 Classification of factors

The previous chapters and sections never described the nature of a factor. However, when you pick up a factor, you should clarify the objective of picking up that factor.

In the design of experiments, factors fall roughly into three categories depending on their nature.

(1) Controllable factor: A factor picked up to select the best level from a set of levels determined.

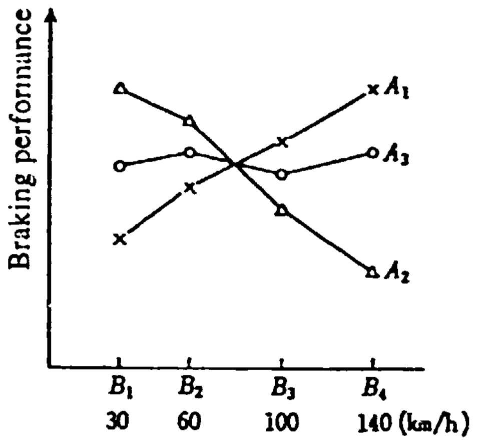
Examples include reaction temperature, reaction time, material brand, and method of finishing. Most of the factors picked up in experiments are controllable factors.

(2) Indicative factor: Refers to a factor which, just like the controllable factor, determines some levels but with which the objective of experiments is not to determine the optimal level, because it is meaningless. This is picked up as a factor because we are interested in the interaction between the indicative factor and the controllable factor.

As shown in the next example, the working conditions and test conditions of an article generally constitute indicative factors.

Example: When, in an experiment designed to identify the optimal brake system for a motor vehicle, the type of brake system (A) and the speed when braked (B) are picked up as factors, B can be considered as an indicative factor. B is picked up as a factor not in order to determine the optimal level of B but to determine the A-B interaction. Assume, for example, that the A-B relationship is as shown in Fig. 6.4. Presumably desirable would be such device as A_3, which maintains constant functions under any condition.

Fig. 6.4 Actual A x B



(3) Block factor: Refers to a factor picked up to stratify the places of experiment in order to increase the precision of the experiments. The levels are unreproducible, so that it would be useless to identify the interaction between the block factor and the controllable factor. (It is often considered that this factor has no interaction with the controllable factor.)

Examples include day, lot, and replication.

When a factor is picked up in the stage of experimental design, it is important to think of which category the factor belongs to. For example,

(i) If A is an indicative factor, experiments must be designed in such a way as to make it possible to monitor the interaction between A and at least either of the controllable factor.

(ii) If A is an indicative factor and B, C, ... are controllable factors, experiments based on the split-plot design must be considered.

(iii) Assume that A is an indicative factor, B a controllable factor, and AxB is significant. In that case, it would be meaningless to determine one of the optimal level combinations of A and B. It is important either to determine the optimal level of B at each level of A or to draw a graph of AxB and monitor the actual interaction status. (See the previous example.)

(iv) If A is a block factor, it would be meaningless to determine the optimal level of A.

§6.3 Procedure for applying the design of experiments

This section briefly explains the procedure for actually using the design of experiments and the precautions to be taken when following each step of the procedure.

(1) Define the purpose of the experiments.
1°) Define what you want to learn. (Even if you think you are sure of it, you tend to become less and less sure as you progress in your discussion.)
2°) Determine the actual characteristics.
(i) Choose the characteristics that best suit the purpose of your experiments.
(ii) Do not try overambitiously to express a characteristic in a single value. Quantification can be considered in the stage of analysis from various angles.
(iii) Pick up the characteristics related to your target characteristics, handling them as characteristics. (Even if characteristic (a) becomes good, it is not good enough if characteristic (b) becomes worse than now.) The number of characteristics is therefore not always one.

3°) Roughly determine the scale of experiments (such as budget, period, and personnel to be involved).

(2) Collect information about these experiments and organize and study them.

1°) Check if related experiments were previously performed. If they were, check how they were performed and what results they brought about.
2°) Create a cause-and-effect diagram (a diagram indicating the relationship between quality characteristics and causes) through a discussion with personnel involved.

(3) Determine which factors to pick up and their levels.

Which factors should you pick up? How should you determine the levels for the factors you have picked up? These are the most important issues in designing experiments. In this process, it is needless to say that technical knowledge (your unique techniques) related to these experiments will play an important role. Here, I will give some precautions to be taken from the viewpoint of the design of experiments.

1°) When you pick up a factor, check which category it belongs to: controllable, indicative, or block. Pay particular attention to indicative factors (Section 6.2).
2°) In the manufacturing industry, the design of experiments is often used

as a method of problem-solving in the stages of research, development, design, and manufacture. It should be noted here that the method of using the design of experiments varies slightly with objectives and places of application.

(i) When you use the design of experiments in the manufacturing stage, the target characteristics are clearly defined in the form of product strength, percentage defective, and other factors. Furthermore, the factors to be picked up and considered are confined to some factors. This therefore raises no major difficulties.

(ii) When you use the design of experiments in the development and design stages, particular consideration not required in the manufacturing stage must be given to two points: (1) selection of factors and (2) method of selecting characteristics.

Concerning (1): Users use a product in various manners. A good product fulfills some performance in whichever way the users may use it. In the development and design of a product, therefore, sufficient consideration must be given to the working conditions of the article.

This is why, in the determination of design conditions, it is necessary to pick up not only a controllable factor but also the working conditions of the article as an indicative factor, thus designing a set of experiments that will examine the interaction between the indicative factor and the controllable factor. It may also be necessary to pick up deterioration status as an indicative factor in order to achieve sFig. functions when subjected to product deterioration.

On the other hand, it will be quite unnecessary to consider the working conditions of the article when you apply the design of experiments in the manufacturing stage.

Concerning (2): As mentioned in (1), the working conditions of the article must be considered in the design stage. Accordingly, the quality characteristics to be considered include not only their averages but also dispersion due to fluctuations in working conditions.

As a characteristic that allows for both averages and dispersion, Genichi Taguchi proposes an SN ratio and a special design of experiments for evaluating that SN ratio (Reference 5).

3°) As for the number of factors, an experiment should first be performed with many factors. Then, as experiments are replicated, the factors are narrowed down to a few.

4°) When it comes to material brand and other quality factors, the levels and number of levels are often determined automatically by the objectives of the experiments. On the other hand, when it comes to reaction temperature and other quality factors, you are quite free to choose any number of levels and whichever levels you like, from the viewpoint of your unique techniques.

The number of levels should desirably be 3 or 2. The width of the levels is another tough challenge. It should not be too large, and not too small either. In earlier stages, it would be rather desirable to take a widish level.

5°) The levels are commonly selected for each factor. When you look at the combination of two factors, A and B for example, you may find a level combination that can be considered clearly inconvenient. In such a case, the two methods described below are conceivable.

(i) Combine A with B to form one factor. In this case, you can use the combination method (Sections 4.5 and 5.4).

(ii) Determine level B for each level A. Assume for example that, in reaction temperature (A) and reaction time (B), the reaction time must not be increased when the reaction temperature is high. In such a case, level B can be determined for each level A as illustrated in Fig. 6.5.

Fig. 6.5 Level B (units: hours)

A \ B	B_1	B_2	B_3
A_1 (1000°C)	7	8	9
A_2 (1100°C)	6	7	8
A_3 (1200°C)	5	6	7

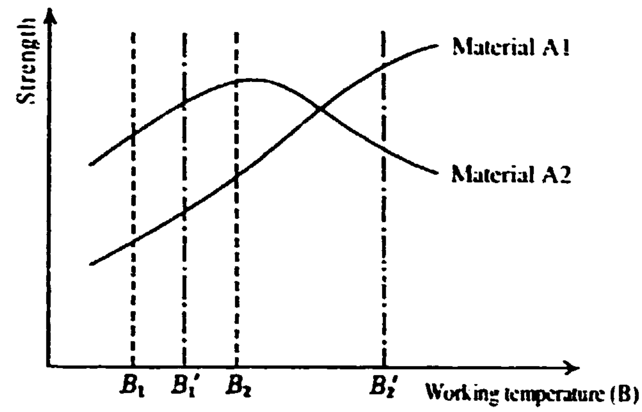
6°) You should desirably use factors and levels which are as concrete as possible. When the reaction time has a level of 1,000°C, for example, there may be a method of achieving this level. If that method is clear, you may want to use that method to specify the factors and levels. In that case, measure the reaction temperature at that time.

7°) Check if the factors picked up are to be mutually interactive.

The interaction or the lack of it between the factors is related to the levels selected. That is, how you select the levels will determine whether the factors will be interactive. In general, using widish levels will probably produce interactions.

Assume for example that the material (a) and working temperature (B) with regard to strength have a relationship as shown in Fig. 6.6. If you select level B as in B_1 and B_2, A x B will not hold. If you select it as in B_1' and B_2', A x B will hold.

Fig. 6.6 Interaction between A and B



(4) Design experiments.

(5) Perform the experiments.

(6) Analyze the experimental data and draw a conclusion.

Steps (4) through (6) are described in Chapters 1 through 5.

1°) In data analysis, the problems given in this document just give a quick once-over ranging from variance analysis to estimation. In actual practice, however, a more in-depth analysis must be conducted. Examples include a comparison with other level combinations and a study of the relationship with standards with consideration given to the optimal level combination and costs.

2) The conclusions obtained from data analysis must be studied from the viewpoint of your unique techniques.

(7) Discuss the conclusion with people involved. Then determine future policies.

The above is a rough description of the application procedure. In each step of the procedure, precautions should be taken, such as (i) discussing sufficiently with people involved and (ii) documenting the findings and conclusions.

Last but not least, I would like to emphasize that consideration in the design stage is important. When you obtain a set of experimental data, the amount of information obtained varies greatly according to whether you have done enough in the design stage or not. If you take various considerations into account in the design stage, you will be able to obtain much information from the experimental data.

References

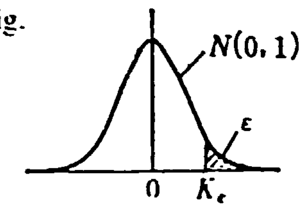
(1) Tadaichi Okuno and Toshiro Hoga: Design of Experiments, published by Baifukan
(2) Quality Control Handbook, revised edition, published by the Japanese Standards Association
(3) Genichi Taguchi: Design of Experiments (Vol. 1 and 2), published by Maruzen
(4) Genichi Taguchi: Offline Quality Control in the Engineering and the Design Department (Quality Control Textbook), published by the Japanese Standards Association
(5) Union of Japanese Scientists and Engineers: Numerical Fig. B, published by the Union of Japanese Scientists and Engineers Press

Attached Fig.s

1. Normal distribution Fig.
2. χ^2 distribution Fig.
3. F distribution Fig.
4. t distribution Fig.
5. Orthogonal Fig. and line-and-dot diagram
6. Line-and-dot diagram for Resolution IV

Attached Fig.s 1 through 4 are excerpts from Shigeichi Moriguchi's "Numerical Fig. A Developed by the Union of Japanese Scientists and Engineer," 1960, (published by the Union of Japanese Scientists and Engineer). Attached Fig. 5 is from C.C. Li, Y.
Washio, T. Iida, and S. Tanimoto's "New Linear Graphics for Orthogonal Array L(2)."

Attached Fig. 1 Normal distribution Fig.



$K_\varepsilon \rightarrow \varepsilon$ (a Fig. for determining .. from K)

K_ε	*=0	1	2	3	4	5	6	7	8	9
0.0*	.5000	.4960	.4920	.4880	.4840	.4801	.4761	.4721	.4681	.4641
0.1*	.4602	.4562	.4522	.4483	.4443	.4404	.4364	.4325	.4286	.4247
0.2*	.4207	.4168	.4129	.4090	.4052	.4013	.3974	.3936	.3897	.3859
0.3*	.3821	.3783	.3745	.3707	.3669	.3632	.3594	.3557	.3520	.3483
0.4*	.3446	.3409	.3372	.3336	.3300	.3264	.3228	.3192	.3156	.3121
0.5*	.3085	.3050	.3015	.2981	.2946	.2912	.2877	.2843	.2810	.2776
0.6*	.2743	.2709	.2676	.2643	.2611	.2578	.2546	.2514	.2483	.2451
0.7*	.2420	.2389	.2358	.2327	.2296	.2266	.2236	.2206	.2177	.2148
0.8*	.2119	.2090	.2061	.2033	.2005	.1977	.1949	.1922	.1894	.1867
0.9*	.1841	.1814	.1788	.1762	.1736	.1711	.1685	.1660	.1635	.1611
1.0*	.1587	.1562	.1539	.1515	.1492	.1469	.1446	.1423	.1401	.1379
1.1*	.1357	.1335	.1314	.1292	.1271	.1251	.1230	.1210	.1190	.1170
1.2*	.1151	.1131	.1112	.1093	.1075	.1056	.1038	.1020	.1003	.0985
1.3*	.0968	.0951	.0934	.0918	.0901	.0885	.0869	.0853	.0838	.0823
1.4*	.0808	.0793	.0778	.0764	.0749	.0735	.0721	.0708	.0694	.0681
1.5*	.0668	.0655	.0643	.0630	.0618	.0606	.0594	.0582	.0571	.0559
1.6*	.0548	.0537	.0526	.0516	.0505	.0495	.0485	.0475	.0465	.0455
1.7*	.0446	.0436	.0427	.0418	.0409	.0401	.0392	.0384	.0375	.0367
1.8*	.0359	.0351	.0344	.0336	.0329	.0322	.0314	.0307	.0301	.0294
1.9*	.0287	.0281	.0274	.0268	.0262	.0256	.0250	.0244	.0239	.0233
2.0*	.0228	.0222	.0217	.0212	.0207	.0202	.0197	.0192	.0188	.0183
2.1*	.0179	.0174	.0170	.0166	.0162	.0158	.0154	.0150	.0146	.0143
2.2*	.0139	.0136	.0132	.0129	.0125	.0122	.0119	.0116	.0113	.0110
2.3*	.0107	.0104	.0102	.0099	.0096	.0094	.0091	.0089	.0087	.0084
2.4*	.0082	.0080	.0078	.0075	.0073	.0071	.0069	.0068	.0066	.0064
2.5*	.0062	.0060	.0059	.0057	.0055	.0054	.0052	.0051	.0049	.0048
2.6*	.0047	.0045	.0044	.0043	.0041	.0040	.0039	.0038	.0037	.0036
2.7*	.0035	.0034	.0033	.0032	.0031	.0030	.0029	.0028	.0027	.0026
2.8*	.0026	.0025	.0024	.0023	.0023	.0022	.0021	.0021	.0020	.0019
2.9*	.0019	.0018	.0018	.0017	.0016	.0016	.0015	.0015	.0014	.0014
3.0*	.0013	.0013	.0013	.0012	.0012	.0011	.0011	.0011	.0010	.0010

- Example: To get the ... when K = 1.96, go right from the 1.9 in the title column at the left end, go down from the 6 in the top title, and read the value there. You will then find .0250.

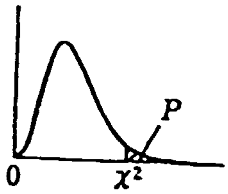
- Note: How to determine the cumulative distribution function $\Phi(u) = \int_{-\infty}^{u} \frac{1}{\sqrt{2\pi}} e^{-x^2/2} dx$ for the normal distribution N(0,1):

- If $u<0$, assume that $|u| = K\varepsilon$ and read ε and assume that $\phi(u) = \varepsilon$
- If $u>0$, assume that $u = K\varepsilon$ and read ε and assume that $\phi(u) = 1 - \varepsilon$

  Examples: $\phi(-1.96) = .0250$,

  $\phi(1.96) = .9750$.

Attached Fig. 2 χ^2 distribution Fig.

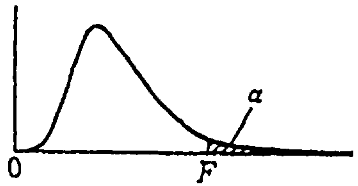


(a Fig. for determining χ^2 from ϕ degrees of freedom and a top probability P)

ϕ \ P	.995	.99	.975	.95	.90	.75	.50	.25	.10	.05	.025	.01	.005	P / ϕ
1	0.0^4393	0.0^3157	0.0^3982	0.0^2393	0.0158	0.102	0.455	1.323	2.71	3.84	5.02	6.63	7.88	1
2	0.0100	0.0201	0.0506	0.103	0.211	0.575	1.386	2.77	4.61	5.99	7.38	9.21	10.60	2
3	0.0717	0.115	0.216	0.352	0.584	1.213	2.37	4.11	6.25	7.81	9.35	11.34	12.84	3
4	0.207	0.297	0.484	0.711	1.064	1.923	3.36	5.39	7.78	9.49	11.14	13.28	14.86	4
5	0.412	0.554	0.831	1.145	1.610	2.67	4.35	6.63	9.24	11.07	12.83	15.09	16.75	5
6	0.676	0.872	1.237	1.635	2.20	3.45	5.35	7.84	10.64	12.59	14.45	16.81	18.55	6
7	0.989	1.239	1.690	2.17	2.83	4.25	6.35	9.04	12.02	14.07	16.01	18.48	20.3	7
8	1.344	1.646	2.18	2.73	3.49	5.07	7.34	10.22	13.36	15.51	17.53	20.1	22.0	8
9	1.735	2.09	2.70	3.33	4.17	5.90	8.34	11.39	14.68	16.92	19.02	21.7	23.6	9
10	2.16	2.56	3.25	3.94	4.87	6.74	9.34	12.55	15.99	18.31	20.5	23.2	25.2	10
11	2.60	3.05	3.82	4.57	5.58	7.58	10.34	13.70	17.28	19.68	21.9	24.7	26.8	11
12	3.07	3.57	4.40	5.23	6.30	8.44	11.34	14.85	18.55	21.0	23.3	26.2	28.3	12
13	3.57	4.11	5.01	5.89	7.04	9.30	12.34	15.98	19.81	22.4	24.7	27.7	29.8	13
14	4.07	4.66	5.63	6.57	7.79	10.17	13.34	17.12	21.1	23.7	26.1	29.1	31.3	14
15	4.60	5.23	6.26	7.26	8.55	11.04	14.34	18.25	22.3	25.0	27.5	30.6	32.8	15
16	5.14	5.81	6.91	7.96	9.31	11.91	15.34	19.37	23.5	26.3	28.8	32.0	34.3	16
17	5.70	6.41	7.56	8.67	10.09	12.79	16.34	20.5	24.8	27.6	30.2	33.4	35.7	17
18	6.26	7.01	8.23	9.39	10.86	13.68	17.34	21.6	26.0	28.9	31.5	34.8	37.2	18
19	6.84	7.63	8.91	10.12	11.65	14.56	18.34	22.7	27.2	30.1	32.9	36.2	38.6	19
20	7.43	8.26	9.59	10.85	12.44	15.45	19.34	23.8	28.4	31.4	34.2	37.6	40.0	20
21	8.03	8.90	10.28	11.59	13.24	16.34	20.3	24.9	29.6	32.7	35.5	38.9	41.4	21
22	8.64	9.54	10.98	12.34	14.04	17.24	21.3	26.0	30.8	33.9	36.8	40.3	42.8	22
23	9.26	10.20	11.69	13.09	14.85	18.14	22.3	27.1	32.0	35.2	38.1	41.6	44.2	23
24	9.89	10.86	12.40	13.85	15.66	19.04	23.3	28.2	33.2	36.4	39.4	43.0	45.6	24
25	10.52	11.52	13.12	14.61	16.47	19.94	24.3	29.3	34.4	37.7	40.6	44.3	46.9	25
26	11.16	12.20	13.84	15.38	17.29	20.8	25.3	30.4	35.6	38.9	41.9	45.6	48.3	26
27	11.81	12.88	14.57	16.15	18.11	21.7	26.3	31.5	36.7	40.1	43.2	47.0	49.6	27
28	12.46	13.56	15.31	16.93	18.94	22.7	27.3	32.6	37.9	41.3	44.5	48.3	51.0	28
29	13.12	14.26	16.05	17.71	19.77	23.6	28.3	33.7	39.1	42.6	45.7	49.6	52.3	29
30	13.79	14.95	16.79	18.49	20.6	24.5	29.3	34.8	40.3	43.8	47.0	50.9	53.7	30
40	20.7	22.2	24.4	26.5	29.1	33.7	39.3	45.6	51.8	55.8	59.3	63.7	66.8	40
50	28.0	29.7	32.4	34.8	37.7	42.9	49.3	56.3	63.2	67.5	71.4	76.2	79.5	50
60	35.5	37.5	40.5	43.2	46.5	52.3	59.3	67.0	74.4	79.1	83.3	88.4	92.0	60
70	43.3	45.4	48.8	51.7	55.3	61.7	69.3	77.6	85.5	90.5	95.0	100.4	104.2	70
80	51.2	53.5	57.2	60.4	64.3	71.1	79.3	88.1	96.6	101.9	106.6	112.3	116.3	80
90	59.2	61.8	65.6	69.1	73.3	80.6	89.3	98.6	107.6	113.1	118.1	124.1	128.3	90
100	67.3	70.1	74.2	77.9	82.4	90.1	99.3	109.1	118.5	124.3	129.6	135.8	140.2	100

- Example 1: The value χ^2 when $\phi = 10$ and P = 0.05 is 18.31. This means that the probability that the random variable that follows the χ^2 distribution with 10 degrees of freedom will be 5%.
- Example 2: The value χ^2 when $\phi = 54$ and P = 0.01 can be determined by $88.4 \times 0.4 + 76.2 \times 0.6 = 81.1$ by using the value when $\phi = 60$ and $\phi = 50$.

Attached Fig. 3 F distribution (5%, 1%)



$F(\phi_1, \phi_2, \alpha)$ α= 0.05 .. lightface **0.01 ... boldface**

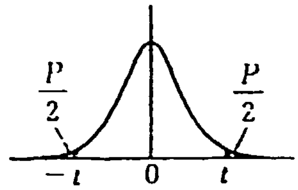
(A Fig. for determining the F value when the top probability is 5% and 1%, from ϕ_1 and ϕ_2 degrees of freedom) (The lightface figures are on the basis of 5%, and the boldface figures are on the basis of 1%.)

ϕ_2 \ ϕ_1	1	2	3	4	5	6	7	8	9	10	12	15	20	24	30	40	60	120	∞	ϕ_1 / ϕ_2
1	161 **4052**	200 **5000**	216 **5403**	225 **5625**	230 **5764**	234 **5859**	237 **5928**	239 **5982**	241 **6022**	242 **6056**	244 **6106**	246 **6157**	248 **6209**	249 **6235**	250 **6261**	251 **6287**	252 **6313**	253 **6339**	254 **6366**	1
2	18.5 **98.5**	19.0 **99.0**	19.2 **99.2**	19.2 **99.2**	19.3 **99.3**	19.3 **99.3**	19.4 **99.4**	19.4 **99.4**	19.4 **99.4**	19.4 **99.4**	19.4 **99.4**	19.4 **99.4**	19.4 **99.4**	19.5 **99.5**	19.5 **99.5**	19.5 **99.5**	19.5 **99.5**	19.5 **99.5**	19.5 **99.5**	2
3	10.1 **34.1**	9.55 **30.8**	9.28 **29.5**	9.12 **28.7**	9.01 **28.2**	8.94 **27.9**	8.89 **27.7**	8.85 **27.5**	8.81 **27.3**	8.79 **27.2**	8.74 **27.1**	8.70 **26.9**	8.66 **26.7**	8.64 **26.6**	8.62 **26.5**	8.59 **26.4**	8.57 **26.3**	8.55 **26.2**	8.53 **26.1**	3
4	7.71 **21.2**	6.94 **18.0**	6.59 **16.7**	6.39 **16.0**	6.26 **15.5**	6.16 **15.2**	6.09 **15.0**	6.04 **14.8**	6.00 **14.7**	5.96 **14.5**	5.91 **14.4**	5.86 **14.2**	5.80 **14.0**	5.77 **13.9**	5.75 **13.8**	5.72 **13.7**	5.69 **13.7**	5.66 **13.6**	5.63 **13.5**	4
5	6.61 **16.3**	5.79 **13.3**	5.41 **12.1**	5.19 **11.4**	5.05 **11.0**	4.95 **10.7**	4.88 **10.5**	4.82 **10.3**	4.77 **10.2**	4.74 **10.1**	4.68 **9.89**	4.62 **9.72**	4.56 **9.55**	4.53 **9.47**	4.50 **9.38**	4.46 **9.29**	4.43 **9.20**	4.40 **9.11**	4.36 **9.02**	5
6	5.99 **13.7**	5.14 **10.9**	4.76 **9.78**	4.53 **9.15**	4.39 **8.75**	4.28 **8.47**	4.21 **8.26**	4.15 **8.10**	4.10 **7.98**	4.06 **7.87**	4.00 **7.72**	3.94 **7.56**	3.87 **7.40**	3.84 **7.31**	3.81 **7.23**	3.77 **7.14**	3.74 **7.06**	3.70 **6.97**	3.67 **6.88**	6
7	5.59 **12.2**	4.74 **9.55**	4.35 **8.45**	4.12 **7.85**	3.97 **7.46**	3.87 **7.19**	3.79 **6.99**	3.73 **6.84**	3.68 **6.72**	3.64 **6.62**	3.57 **6.47**	3.51 **6.31**	3.44 **6.16**	3.41 **6.07**	3.38 **5.99**	3.34 **5.91**	3.30 **5.82**	3.27 **5.74**	3.23 **5.65**	7
8	5.32 **11.3**	4.46 **8.65**	4.07 **7.59**	3.84 **7.01**	3.69 **6.63**	3.58 **6.37**	3.50 **6.18**	3.44 **6.03**	3.39 **5.91**	3.35 **5.81**	3.28 **5.67**	3.22 **5.52**	3.15 **5.36**	3.12 **5.28**	3.08 **5.20**	3.04 **5.12**	3.01 **5.03**	2.97 **4.95**	2.93 **4.86**	8
9	5.12 **10.6**	4.26 **8.02**	3.86 **6.99**	3.63 **6.42**	3.48 **6.06**	3.37 **5.80**	3.29 **5.61**	3.23 **5.47**	3.18 **5.35**	3.14 **5.26**	3.07 **5.11**	3.01 **4.96**	2.94 **4.81**	2.90 **4.73**	2.86 **4.65**	2.83 **4.57**	2.79 **4.48**	2.75 **4.40**	2.71 **4.31**	9
10	4.96 **10.0**	4.10 **7.56**	3.71 **6.55**	3.48 **5.99**	3.33 **5.64**	3.22 **5.39**	3.14 **5.20**	3.07 **5.06**	3.02 **4.94**	2.98 **4.85**	2.91 **4.71**	2.84 **4.56**	2.77 **4.41**	2.74 **4.33**	2.70 **4.25**	2.66 **4.17**	2.62 **4.08**	2.58 **4.00**	2.54 **3.91**	10
11	4.84 **9.65**	3.98 **7.21**	3.59 **6.22**	3.36 **5.67**	3.20 **5.32**	3.09 **5.07**	3.01 **4.89**	2.95 **4.74**	2.90 **4.63**	2.85 **4.54**	2.79 **4.40**	2.72 **4.25**	2.65 **4.10**	2.61 **4.02**	2.57 **3.94**	2.53 **3.86**	2.49 **3.78**	2.45 **3.69**	2.40 **3.60**	11
12	4.75 **9.33**	3.89 **6.93**	3.49 **5.95**	3.26 **5.41**	3.11 **5.06**	3.00 **4.82**	2.91 **4.64**	2.85 **4.50**	2.80 **4.39**	2.75 **4.30**	2.69 **4.16**	2.62 **4.01**	2.54 **3.86**	2.51 **3.78**	2.47 **3.70**	2.43 **3.62**	2.38 **3.54**	2.34 **3.45**	2.30 **3.36**	12
13	4.67 **9.07**	3.81 **6.70**	3.41 **5.74**	3.18 **5.21**	3.03 **4.86**	2.92 **4.62**	2.83 **4.44**	2.77 **4.30**	2.71 **4.19**	2.67 **4.10**	2.60 **3.96**	2.53 **3.82**	2.46 **3.66**	2.42 **3.59**	2.38 **3.51**	2.34 **3.43**	2.30 **3.34**	2.25 **3.25**	2.21 **3.17**	13
14	4.60 **8.86**	3.74 **6.51**	3.34 **5.56**	3.11 **5.04**	2.96 **4.70**	2.85 **4.46**	2.76 **4.28**	2.70 **4.14**	2.65 **4.03**	2.60 **3.94**	2.53 **3.80**	2.46 **3.66**	2.39 **3.51**	2.35 **3.43**	2.31 **3.35**	2.27 **3.27**	2.22 **3.18**	2.18 **3.09**	2.13 **3.00**	14
15	4.54 **8.68**	3.68 **6.36**	3.29 **5.42**	3.06 **4.89**	2.90 **4.56**	2.79 **4.32**	2.71 **4.14**	2.64 **4.00**	2.59 **3.89**	2.54 **3.80**	2.48 **3.67**	2.40 **3.52**	2.33 **3.37**	2.29 **3.29**	2.25 **3.21**	2.20 **3.13**	2.16 **3.05**	2.11 **2.96**	2.07 **2.87**	15
16	4.49 **8.53**	3.63 **6.23**	3.24 **5.29**	3.01 **4.77**	2.85 **4.44**	2.74 **4.20**	2.66 **4.03**	2.59 **3.89**	2.54 **3.78**	2.49 **3.69**	2.42 **3.55**	2.35 **3.41**	2.28 **3.26**	2.24 **3.18**	2.19 **3.10**	2.15 **3.02**	2.11 **2.93**	2.06 **2.84**	2.01 **2.75**	16
17	4.45 **8.40**	3.59 **6.11**	3.20 **5.18**	2.96 **4.67**	2.81 **4.34**	2.70 **4.10**	2.61 **3.93**	2.55 **3.79**	2.49 **3.68**	2.45 **3.59**	2.38 **3.46**	2.31 **3.31**	2.23 **3.16**	2.19 **3.08**	2.15 **3.00**	2.10 **2.92**	2.06 **2.83**	2.01 **2.75**	1.96 **2.65**	17

18	4.41	3.55	3.16	2.93	2.77	2.66	2.58	2.51	2.46	2.41	2.34	2.27	2.19	2.15	2.11	2.06	2.02	1.97	1.92	18
	8.29	6.01	5.09	4.58	4.25	4.01	3.84	3.71	3.60	3.51	3.37	3.23	3.08	3.00	2.92	2.84	2.75	2.66	2.57	
19	4.38	3.52	3.13	2.90	2.74	2.63	2.54	2.48	2.42	2.38	2.31	2.23	2.16	2.11	2.07	2.03	1.98	1.93	1.88	19
	8.18	5.93	5.01	4.50	4.17	3.94	3.77	3.63	3.52	3.43	3.30	3.15	3.00	2.92	2.84	2.76	2.67	2.58	2.49	
20	4.35	3.49	3.10	2.87	2.71	2.60	2.51	2.45	2.39	2.35	2.28	2.20	2.12	2.08	2.04	1.99	1.95	1.90	1.84	20
	8.10	5.85	4.94	4.43	4.10	3.87	3.70	3.56	3.46	3.37	3.23	3.09	2.94	2.86	2.78	2.69	2.61	2.52	2.42	
21	4.32	3.47	3.07	2.84	2.68	2.57	2.49	2.42	2.37	2.32	2.25	2.18	2.10	2.05	2.01	1.96	1.92	1.87	1.81	21
	8.02	5.78	4.87	4.37	4.04	3.81	3.64	3.51	3.40	3.31	3.17	3.03	2.88	2.80	2.72	2.64	2.55	2.46	2.36	
22	4.30	3.44	3.05	2.82	2.66	2.55	2.46	2.40	2.34	2.30	2.23	2.15	2.07	2.03	1.98	1.94	1.89	1.84	1.78	22
	7.95	5.72	4.82	4.31	3.99	3.76	3.59	3.45	3.35	3.26	3.12	2.98	2.83	2.75	2.67	2.58	2.50	2.40	2.31	
23	4.28	3.42	3.03	2.80	2.64	2.53	2.44	2.37	2.32	2.27	2.20	2.13	2.05	2.00	1.96	1.91	1.86	1.81	1.76	23
	7.88	5.66	4.76	4.26	3.94	3.71	3.54	3.41	3.30	3.21	3.07	2.93	2.78	2.70	2.62	2.54	2.45	2.35	2.26	
24	4.26	3.40	3.01	2.78	2.62	2.51	2.42	2.36	2.30	2.25	2.18	2.11	2.03	1.98	1.94	1.89	1.84	1.79	1.73	24
	7.82	5.61	4.72	4.22	3.90	3.67	3.50	3.36	3.26	3.17	3.03	2.89	2.74	2.66	2.58	2.49	2.40	2.31	2.21	
25	4.24	3.39	2.99	2.76	2.60	2.49	2.40	2.34	2.28	2.24	2.16	2.09	2.01	1.96	1.92	1.87	1.82	1.77	1.71	25
	7.77	5.57	4.68	4.18	3.86	3.63	3.46	3.32	3.22	3.13	2.99	2.85	2.70	2.62	2.54	2.45	2.36	2.27	2.17	
26	4.23	3.37	2.98	2.74	2.59	2.47	2.39	2.32	2.27	2.22	2.15	2.07	1.99	1.95	1.90	1.85	1.80	1.75	1.69	26
	7.72	5.53	4.64	4.14	3.82	3.59	3.42	3.29	3.18	3.09	2.96	2.82	2.66	2.58	2.50	2.42	2.33	2.23	2.13	
27	4.21	3.35	2.96	2.73	2.57	2.46	2.37	2.31	2.25	2.20	2.13	2.06	1.97	1.93	1.88	1.84	1.79	1.73	1.67	27
	7.68	5.49	4.60	4.11	3.78	3.56	3.39	3.26	3.15	3.06	2.93	2.78	2.63	2.55	2.47	2.38	2.29	2.20	2.10	
28	4.20	3.34	2.95	2.71	2.56	2.45	2.36	2.29	2.24	2.19	2.12	2.04	1.96	1.91	1.87	1.82	1.77	1.71	1.65	28
	7.64	5.45	4.57	4.07	3.75	3.53	3.36	3.23	3.12	3.03	2.90	2.75	2.60	2.52	2.44	2.35	2.26	2.17	2.06	
29	4.18	3.33	2.93	2.70	2.55	2.43	2.35	2.28	2.22	2.18	2.10	2.03	1.94	1.90	1.85	1.81	1.75	1.70	1.64	29
	7.60	5.42	4.54	4.04	3.73	3.50	3.33	3.20	3.09	3.00	2.87	2.73	2.57	2.49	2.41	2.33	2.23	2.14	2.03	
30	4.17	3.32	2.92	2.69	2.53	2.42	2.33	2.27	2.21	2.16	2.09	2.01	1.93	1.89	1.84	1.79	1.74	1.68	1.62	30
	7.56	5.39	4.51	4.02	3.70	3.47	3.30	3.17	3.07	2.98	2.84	2.70	2.55	2.47	2.39	2.30	2.21	2.11	2.01	
40	4.08	3.23	2.84	2.61	2.45	2.34	2.25	2.18	2.12	2.08	2.00	1.92	1.84	1.79	1.74	1.69	1.64	1.58	1.51	40
	7.31	5.18	4.31	3.83	3.51	3.29	3.12	2.99	2.89	2.80	2.66	2.52	2.37	2.29	2.20	2.11	2.02	1.92	1.80	
60	4.00	3.15	2.76	2.53	2.37	2.25	2.17	2.10	2.04	1.99	1.92	1.84	1.75	1.70	1.65	1.59	1.53	1.47	1.39	60
	7.08	4.98	4.13	3.65	3.34	3.12	2.95	2.82	2.72	2.63	2.50	2.35	2.20	2.12	2.03	1.94	1.84	1.73	1.60	
120	3.92	3.07	2.68	2.45	2.29	2.18	2.09	2.02	1.96	1.91	1.83	1.75	1.66	1.61	1.55	1.50	1.43	1.35	1.25	120
	6.85	4.79	3.95	3.48	3.17	2.96	2.79	2.66	2.56	2.47	2.34	2.19	2.03	1.95	1.86	1.76	1.66	1.53	1.38	
∞	3.84	3.00	2.60	2.37	2.21	2.10	2.01	1.94	1.88	1.83	1.75	1.67	1.57	1.52	1.46	1.39	1.32	1.22	1.00	∞
	6.63	4.61	3.78	3.32	3.02	2.80	2.64	2.51	2.41	2.32	2.18	2.04	1.88	1.79	1.70	1.59	1.47	1.32	1.00	
ϕ_2 / ϕ_1	1	2	3	4	5	6	7	8	9	10	12	15	20	24	30	40	60	120	∞	ϕ_1 / ϕ_2

- Example 1: The dot at top 5% in the F distribution when the freedom $\phi_1 = 5$ and $\phi_2 = 10$ is 3.33. The dot at top 1% is 5.64.
- Example 2: To determine the dot at bottom 5% in the F distribution when the freedom is (5,10), find the value for the case when $\phi_1 = 10$ and $\phi_2 = 5$, and get 4.74. Then take its inverse and get 1/4.74.
- Note: For interpolation at dots with many degrees of freedom, use the primary interpolation based on $120/\phi$.

Attached Fig. 4 t distribution



$\phi, P \rightarrow t$ (a Fig. for determining t from ϕ degrees of freedom and the both-side probability P.)

ϕ \ P	0.50	0.40	0.30	0.20	0.10	0.05	0.02	0.01	0.001	P / ϕ
1	1.000	1.376	1.963	3.078	6.314	12.706	31.821	63.657	636.619	1
2	0.816	1.061	1.386	1.886	2.920	4.303	6.965	9.925	31.598	2
3	0.765	0.978	1.250	1.638	2.353	3.182	4.541	5.841	12.941	3
4	0.741	0.941	1.190	1.533	2.132	2.776	3.747	4.604	8.610	4
5	0.727	0.920	1.156	1.476	2.015	2.571	3.365	4.032	6.859	5
6	0.718	0.906	1.134	1.440	1.943	2.447	3.143	3.707	5.959	6
7	0.711	0.896	1.119	1.415	1.895	2.365	2.998	3.499	5.405	7
8	0.706	0.889	1.108	1.397	1.860	2.306	2.896	3.355	5.041	8
9	0.703	0.883	1.100	1.383	1.833	2.262	2.821	3.250	4.781	9
10	0.700	0.879	1.093	1.372	1.812	2.228	2.764	3.169	4.587	10
11	0.697	0.876	1.088	1.363	1.796	2.201	2.718	3.106	4.437	11
12	0.695	0.873	1.083	1.356	1.782	2.179	2.681	3.055	4.318	12
13	0.694	0.870	1.079	1.350	1.771	2.160	2.650	3.012	4.221	13
14	0.692	0.868	1.076	1.345	1.761	2.145	2.624	2.977	4.140	14
15	0.691	0.866	1.074	1.341	1.753	2.131	2.602	2.947	4.073	15
16	0.690	0.865	1.071	1.337	1.746	2.120	2.583	2.921	4.015	16
17	0.689	0.863	1.069	1.333	1.740	2.110	2.567	2.898	3.965	17
18	0.688	0.862	1.067	1.330	1.734	2.101	2.552	2.878	3.922	18
19	0.688	0.861	1.066	1.328	1.729	2.093	2.539	2.861	3.883	19
20	0.687	0.860	1.064	1.325	1.725	2.086	2.528	2.845	3.850	20
21	0.686	0.859	1.063	1.323	1.721	2.080	2.518	2.831	3.819	21
22	0.686	0.858	1.061	1.321	1.717	2.074	2.508	2.819	3.792	22
23	0.685	0.858	1.060	1.319	1.714	2.069	2.500	2.807	3.767	23
24	0.685	0.857	1.059	1.318	1.711	2.064	2.492	2.797	3.745	24
25	0.684	0.856	1.058	1.316	1.708	2.060	2.485	2.787	3.725	25
26	0.684	0.856	1.058	1.315	1.706	2.056	2.479	2.779	3.707	26
27	0.684	0.855	1.057	1.314	1.703	2.052	2.473	2.771	3.690	27
28	0.683	0.855	1.056	1.313	1.701	2.048	2.467	2.763	3.674	28
29	0.683	0.854	1.055	1.311	1.699	2.045	2.462	2.756	3.659	29
30	0.683	0.854	1.055	1.310	1.697	2.042	2.457	2.750	3.646	30
40	0.681	0.851	1.050	1.303	1.684	2.021	2.423	2.704	3.551	40
60	0.679	0.848	1.046	1.296	1.671	2.000	2.390	2.660	3.460	60
120	0.677	0.845	1.041	1.289	1.658	1.980	2.358	2.617	3.373	120
∞	0.674	0.842	1.036	1.282	1.645	1.960	2.326	2.576	3.291	∞

- Example: The value t when $\phi = 10$ and P = 0.05 is 2.228. This means that the probability that the random variable that follows the t-distribution with 10 degrees of freedom occurs with an absolute value of 2.228 or above is 5%.
- Note: When $\phi > 30$, primary interpolation based on $120/\phi$ is convenient.

Attached Fig. 5 Orthogonal array and line-and-dot diagram

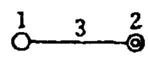
- Note 1: No. represents an experiment number, while column numbers represent the numbers of columns in the orthogonal array.
- Note 2: The interaction Fig. is designed for determining the two-factor interaction between two columns.
- Note 3: The groups for each column in the orthogonal array are indicated by using the following symbols in the framework of assignment:

Group	Symbol	Only for $L_{32}(2^{31})$
Group 1	○	Groups 1 and 2
Group 2	◎	Group 3
Group 3	⊙	Group 4
Group 4	●	Group 5

$L_4(2^3)$

No. \ Column #	1	2	3
1	1	1	1
2	1	2	2
3	2	1	2
4	2	2	1
Components	a	b	a b
	Group 1	Group 2	

(1)



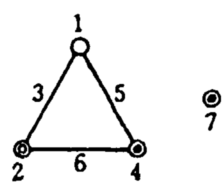
$L_8(2^7)$

No. \ Column #	1	2	3	4	5	6	7
1	1	1	1	1	1	1	1
2	1	1	1	2	2	2	2
3	1	2	2	1	1	2	2
4	1	2	2	2	2	1	1
5	2	1	2	1	2	1	2
6	2	1	2	2	1	2	1
7	2	2	1	1	2	2	1
8	2	2	1	2	1	1	2
Components	a	b	a b	c	a c	b c	a b c
	Group 1	Group 2		Group 2			

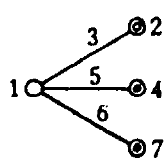
Interaction Fig. between two columns

Column \ Column	1	2	3	4	5	6	7
	(1)	3	2	5	4	7	6
		(2)	1	6	7	4	5
			(3)	7	6	5	4
				(4)	1	2	3
					(5)	3	2
						(6)	1
							(7)

(1)



(2)

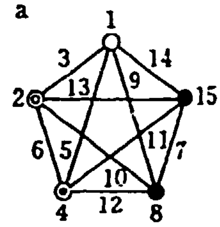


$L_{16}(2^{15})$

No. \ Column #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2
3	1	1	1	2	2	2	2	1	1	1	1	2	2	2	2
4	1	1	1	2	2	2	2	2	2	2	2	1	1	1	1
5	1	2	2	1	1	2	2	1	1	2	2	1	1	2	2
6	1	2	2	1	1	2	2	2	2	1	1	2	2	1	1
7	1	2	2	2	2	1	1	1	1	2	2	2	2	1	1
8	1	2	2	2	2	1	1	2	2	1	1	1	1	2	2
9	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
10	2	1	2	1	2	1	2	2	1	2	1	2	1	2	1
11	2	1	2	2	1	2	1	1	2	1	2	2	1	2	1
12	2	1	2	2	1	2	1	2	1	2	1	1	2	1	2
13	2	2	1	1	2	2	1	1	2	2	1	1	2	2	1
14	2	2	1	1	2	2	1	2	1	1	2	2	1	1	2
15	2	2	1	2	1	1	2	1	2	2	1	2	1	1	2
16	2	2	1	2	1	1	2	2	1	1	2	1	2	2	1
Components	a	b	a b	c	a c	b c	a b c	d	a d	b d	a b d	c d	a c d	b c d	a b c d
	Group 1	Group 2		Group 3				Group 4							

(1)

a



b

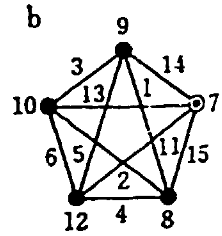
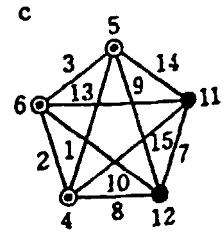


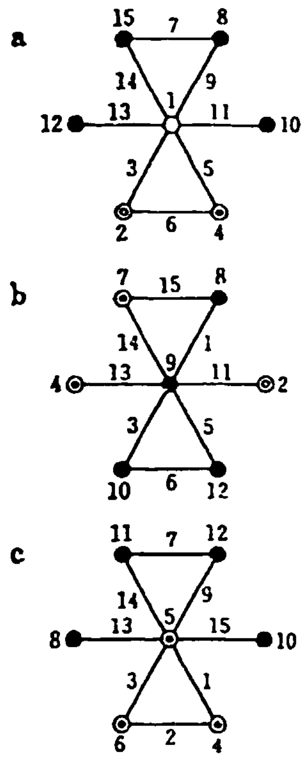
Fig. of interaction between two columns

Column \ Column	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	(1)	3	2	5	4	7	6	9	8	11	10	13	12	15	14
		(2)	1	6	7	4	5	10	11	8	9	14	15	12	13
			(3)	7	6	5	4	11	10	9	8	15	14	13	12
				(4)	1	2	3	12	13	14	15	8	9	10	11
					(5)	3	2	13	12	15	14	9	8	11	10
						(6)	1	14	15	12	13	10	11	8	9
							(7)	15	14	13	12	11	10	9	8
								(8)	1	2	3	4	5	6	7
									(9)	3	2	5	4	7	6
										(10)	1	6	7	4	5
											(11)	7	6	5	4
												(12)	1	2	3
													(13)	3	2
														(14)	1

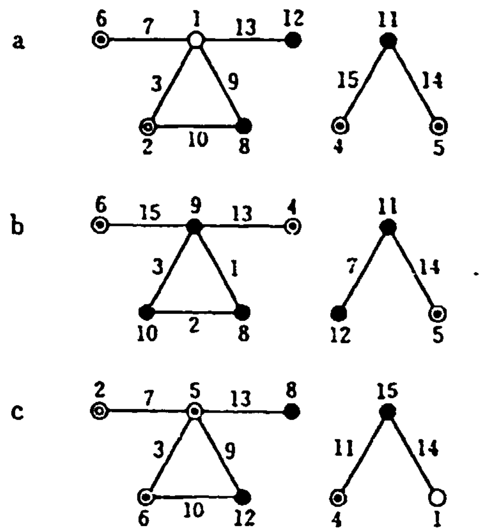
c



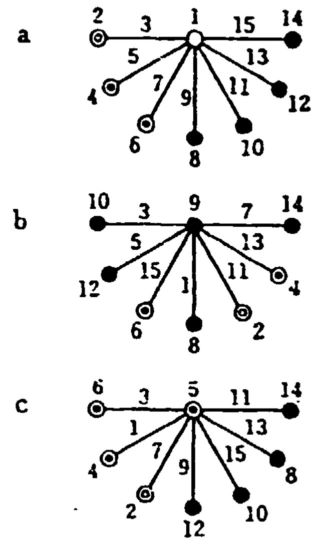
(2)



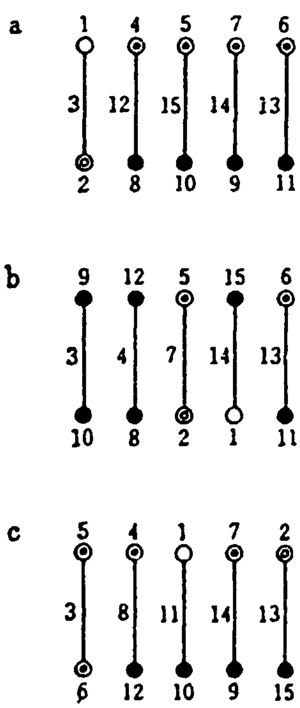
(3)



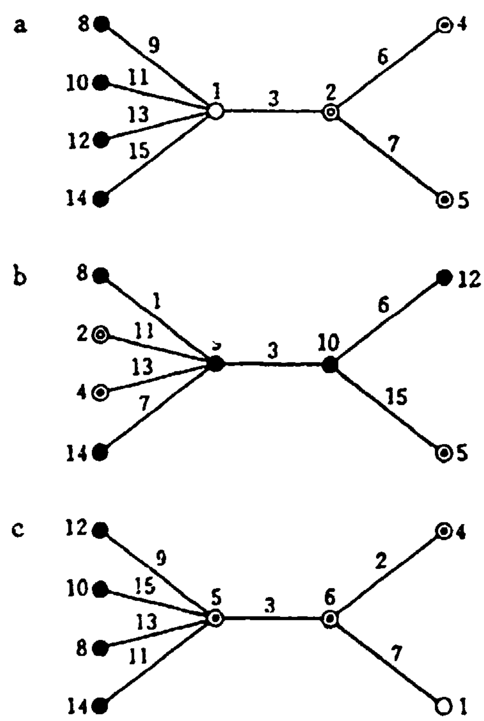
(4)



(5)



(6)

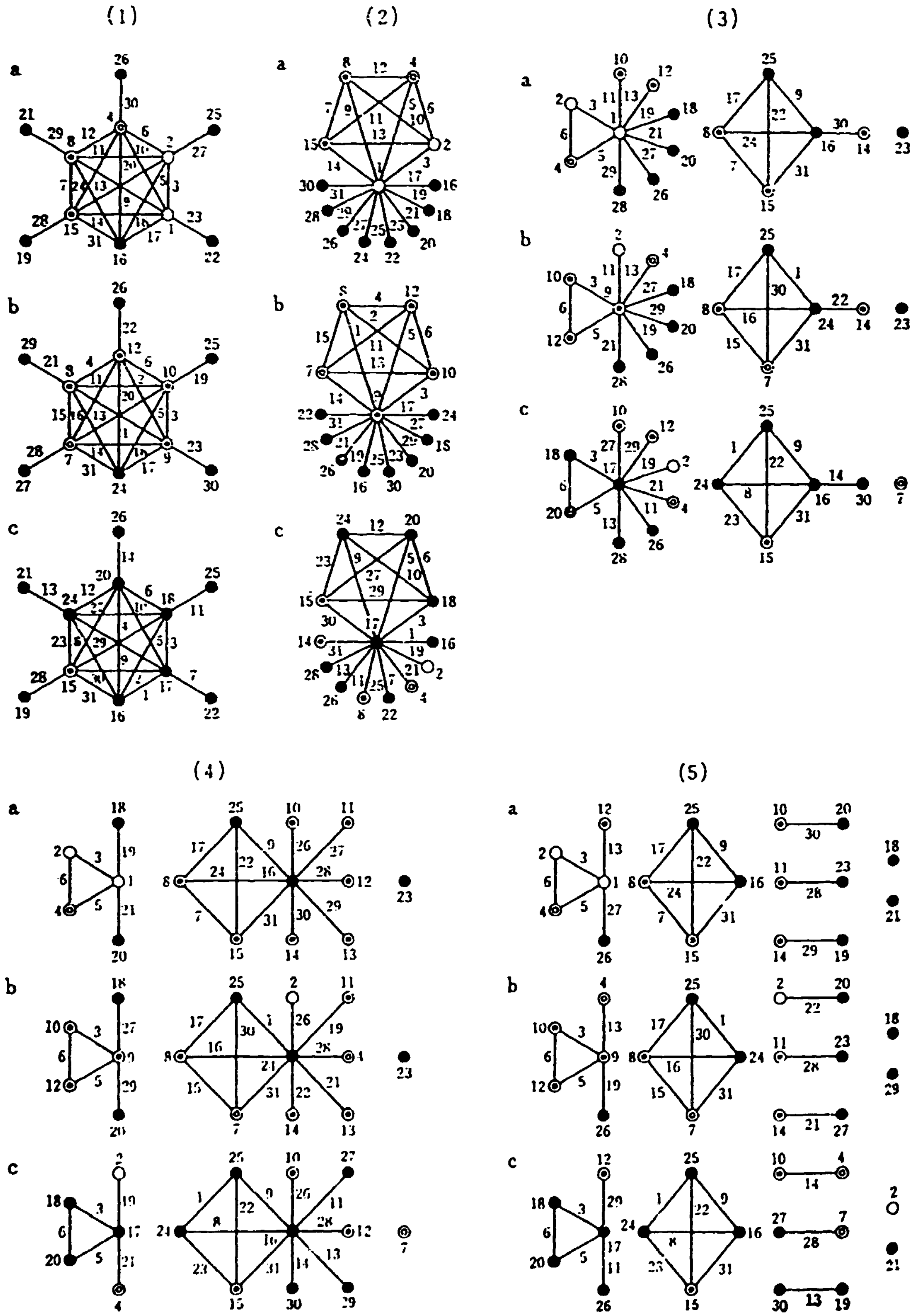


$L_{32}(2^{31})$

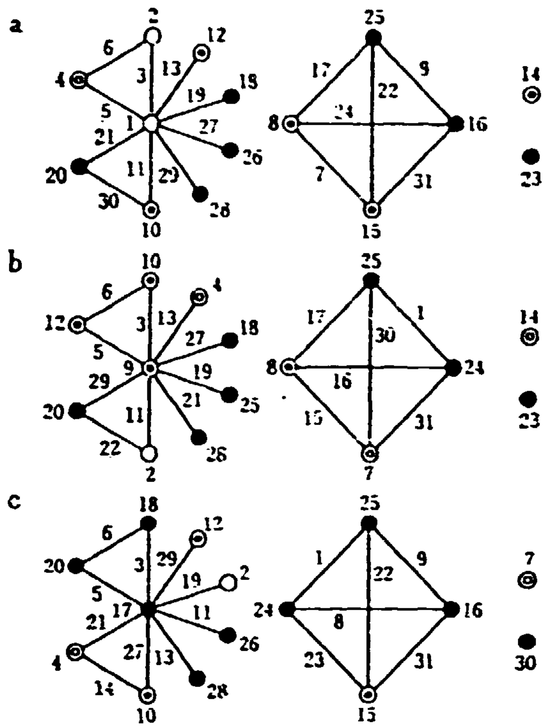
No. \ Column #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
3	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2
4	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1
5	1	1	1	2	2	2	2	1	1	1	1	2	2	2	2	1	1	1	1	2	2	2	2	1	1	1	1	2	2	2	2
6	1	1	1	2	2	2	2	1	1	1	1	2	2	2	2	2	2	2	2	1	1	1	1	2	2	2	2	1	1	1	1
7	1	1	1	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	1	1	1	1
8	1	1	1	2	2	2	2	2	2	2	2	1	1	1	1	2	2	2	2	1	1	1	1	1	1	1	1	2	2	2	2
9	1	2	2	1	1	2	2	1	1	2	2	1	1	2	2	1	1	2	2	1	1	2	2	1	1	2	2	1	1	2	2
10	1	2	2	1	1	2	2	1	1	2	2	1	1	2	2	2	2	1	1	2	2	1	1	2	2	1	1	2	2	1	1
11	1	2	2	1	1	2	2	2	2	1	1	2	2	1	1	1	1	2	2	1	1	2	2	2	2	1	1	2	2	1	1
12	1	2	2	1	1	2	2	2	2	1	1	2	2	1	1	2	2	1	1	2	2	1	1	1	1	2	2	1	1	2	2
13	1	2	2	2	2	1	1	1	1	2	2	2	2	1	1	1	1	2	2	2	2	1	1	1	1	2	2	2	2	1	1
14	1	2	2	2	2	1	1	1	1	2	2	2	2	1	1	2	2	1	1	1	1	2	2	2	2	1	1	1	1	2	2
15	1	2	2	2	2	1	1	2	2	1	1	1	1	2	2	1	1	2	2	2	2	1	1	2	2	1	1	1	1	2	2
16	1	2	2	2	2	1	1	2	2	1	1	1	1	2	2	2	2	1	1	1	1	2	2	1	1	2	2	2	2	1	1
17	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
18	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1
19	2	1	2	1	2	1	2	2	1	2	1	2	1	2	1	1	2	1	2	1	2	1	2	2	1	2	1	2	1	2	1
20	2	1	2	1	2	1	2	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	1	2	1	2	1	2	1	2
21	2	1	2	2	1	2	1	1	2	1	2	2	1	2	1	1	2	1	2	2	1	2	1	1	2	1	2	2	1	2	1
22	2	1	2	2	1	2	1	1	2	1	2	2	1	2	1	2	1	2	1	1	2	1	2	2	1	2	1	1	2	1	2
23	2	1	2	2	1	2	1	2	1	2	1	1	2	1	2	1	2	1	2	2	1	2	1	2	1	2	1	1	2	1	2
24	2	1	2	2	1	2	1	2	1	2	1	1	2	1	2	2	1	2	1	1	2	1	2	1	2	1	2	2	1	2	1
25	2	2	1	1	2	2	1	1	2	2	1	1	2	2	1	1	2	2	1	1	2	2	1	1	2	2	1	1	2	2	1
26	2	2	1	1	2	2	1	1	2	2	1	1	2	2	1	2	1	1	2	2	1	1	2	2	1	1	2	2	1	1	2
27	2	2	1	1	2	2	1	2	1	1	2	2	1	1	2	1	2	2	1	1	2	2	1	2	1	1	2	2	1	1	2
28	2	2	1	1	2	2	1	2	1	1	2	2	1	1	2	2	1	1	2	2	1	1	2	1	2	2	1	1	2	2	1
29	2	2	1	2	1	1	2	1	2	2	1	2	1	1	2	1	2	2	1	2	1	1	2	1	2	2	1	2	1	1	2
30	2	2	1	2	1	1	2	1	2	2	1	2	1	1	2	2	1	1	2	1	2	2	1	2	1	1	2	1	2	2	1
31	2	2	1	2	1	1	2	2	1	1	2	1	2	2	1	1	2	2	1	2	1	1	2	2	1	1	2	1	2	2	1
32	2	2	1	2	1	1	2	2	1	1	2	1	2	2	1	2	1	1	2	1	2	2	1	1	2	2	1	2	1	1	2
Components	a	b	ab	c	ac	bc	abc	d	ad	bd	abd	cd	acd	bcd	abcd	e	ae	be	abe	ce	ace	bce	abce	de	ade	bde	abde	cde	acde	bcde	abcde
	Group 1	Group 2		Group 3				Group 4								Group 4															

Fig. of interaction between two columns

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
(1)	3	2	5	4	7	6	9	8	11	10	13	12	15	14	17	16	19	18	21	20	23	22	25	24	27	26	29	28	31	30
	(2)	1	6	7	4	5	10	11	8	9	14	15	12	13	18	19	16	17	22	23	20	21	26	27	24	25	30	31	28	29
		(3)	7	6	5	4	11	10	9	8	15	14	13	12	19	18	17	16	23	22	21	20	27	26	25	24	31	30	29	28
			(4)	1	2	3	12	13	14	15	8	9	10	11	20	21	22	23	16	17	18	19	28	29	30	31	24	25	26	27
				(5)	3	2	13	12	15	14	9	8	11	10	21	20	23	22	17	16	19	18	29	28	31	30	25	24	27	26
					(6)	1	14	15	12	13	10	11	8	9	22	23	20	21	18	19	16	17	30	31	28	29	26	27	24	25
						(7)	15	14	13	12	11	10	9	8	23	22	21	20	19	18	17	16	31	30	29	28	27	26	25	24
							(8)	1	2	3	4	5	6	7	24	25	26	27	28	29	30	31	16	17	18	19	20	21	22	23
								(9)	3	2	5	4	7	6	25	24	27	26	29	28	31	30	17	16	19	18	21	20	23	22
									(10)	1	6	7	4	5	26	27	24	25	30	31	28	29	18	19	16	17	22	23	20	21
										(11)	7	6	5	4	27	26	25	24	31	30	29	28	19	18	17	16	23	22	21	20
											(12)	1	2	3	28	29	30	31	24	25	26	27	20	21	22	23	16	17	18	19
												(13)	3	2	29	28	31	30	25	24	27	26	21	20	23	22	17	16	19	18
													(14)	1	30	31	28	29	26	27	24	25	22	23	20	21	18	19	16	17
														(15)	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
															(16)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
																(17)	3	2	5	4	7	6	9	8	11	10	13	12	15	14
																	(18)	1	6	7	4	5	10	11	8	9	14	15	12	13
																		(19)	7	6	5	4	11	10	9	8	15	14	13	12
																			(20)	1	2	3	12	13	14	15	8	9	10	11
																				(21)	3	2	13	12	15	14	9	8	11	10
																					(22)	1	14	15	12	13	10	11	8	9
																						(23)	15	14	13	12	11	10	9	8
																							(24)	1	2	3	4	5	6	7
																								(25)	3	2	5	4	7	6
																									(26)	1	6	7	4	5
																										(27)	7	6	5	4
																											(28)	1	2	3
																												(29)	3	2
																													(30)	1


(1)
(2)
(3)
(4)
(5)
a
b
c

(6)



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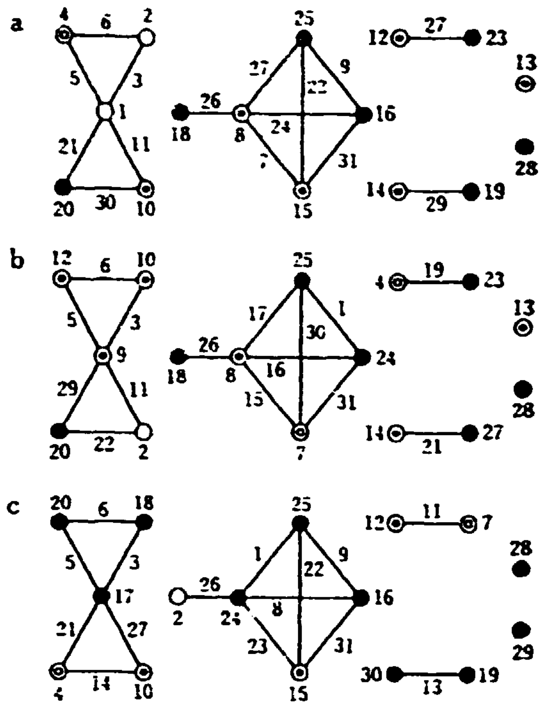

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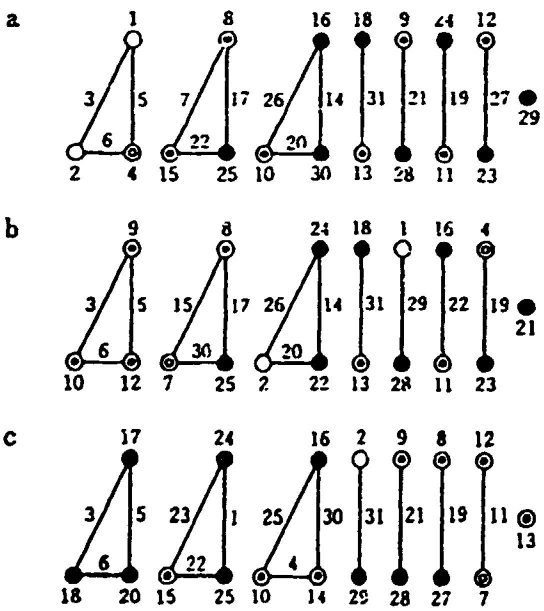

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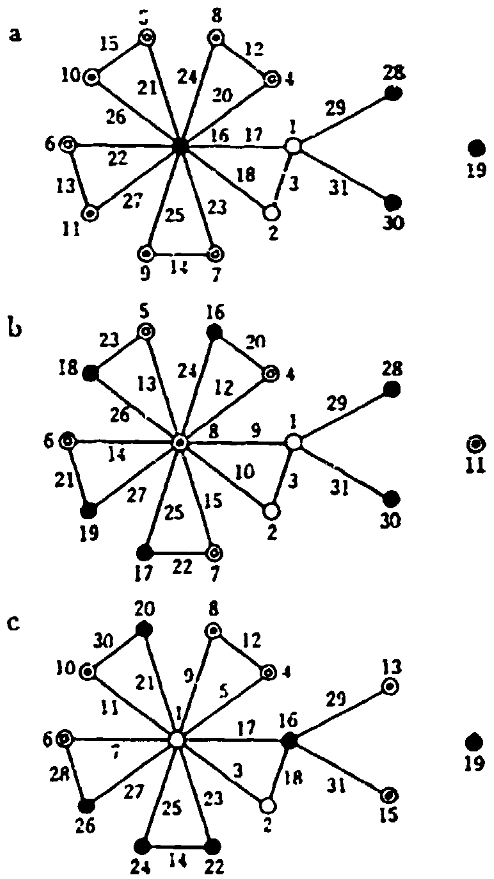
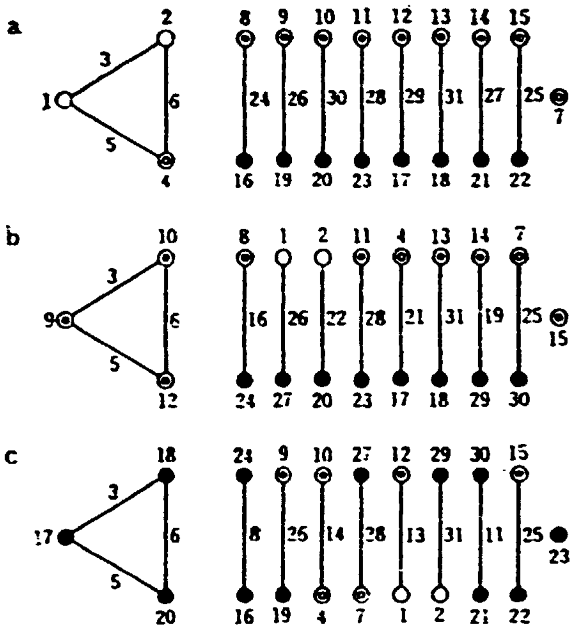


(10)



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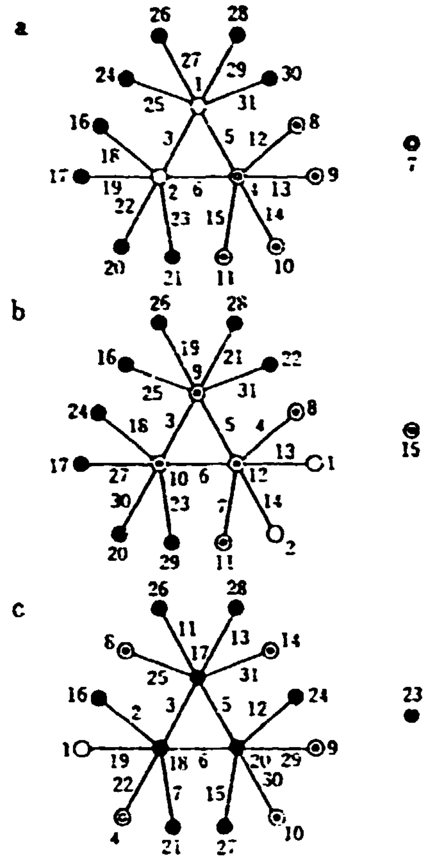
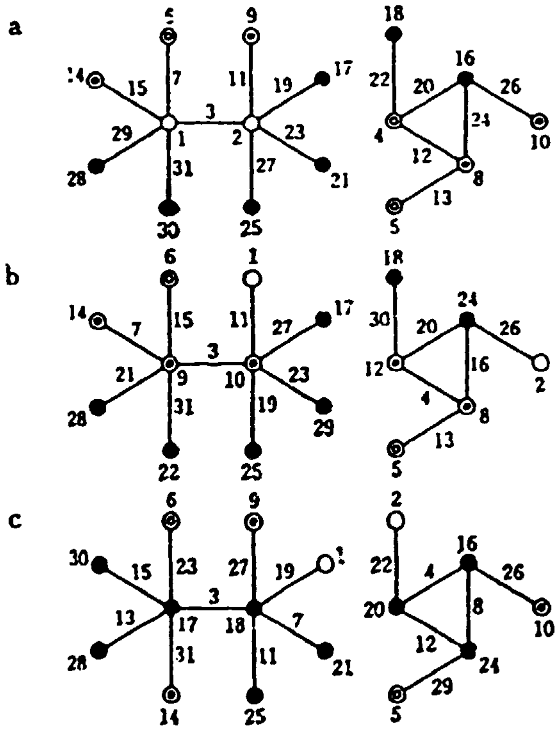
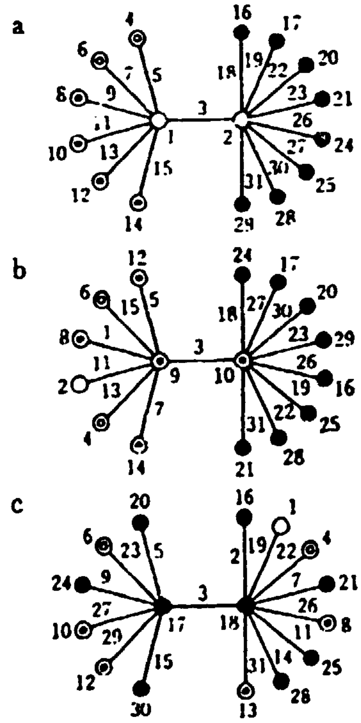


(12)



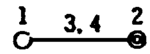
(13)



$L_9(3^4)$

No. \ Column #	1	2	3	4
1	1	1	1	1
2	1	2	2	2
3	1	3	3	3
4	2	1	2	3
5	2	2	3	1
6	2	3	1	2
7	3	1	3	2
8	3	2	1	3
9	3	3	2	1
Components	a	b	a b	a b^2
	Group 1	Group 2		

(1)



$L_{27}(3^{13})$

No. \ Column #	1	2	3	4	5	6	7	8	9	10	11	12	13
1	1	1	1	1	1	1	1	1	1	1	1	1	1
2	1	1	1	1	2	2	2	2	2	2	2	2	2
3	1	1	1	1	3	3	3	3	3	3	3	3	3
4	1	2	2	2	1	1	1	2	2	2	3	3	3
5	1	2	2	2	2	2	2	3	3	3	1	1	1
6	1	2	2	2	3	3	3	1	1	1	2	2	2
7	1	3	3	3	1	1	1	3	3	3	2	2	2
8	1	3	3	3	2	2	2	1	1	1	3	3	3
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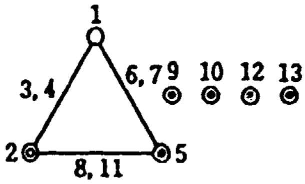
26	3	3	2	1	2	1	3	1	3	2	3	2	1
27	3	3	2	1	3	2	1	2	1	3	1	3	2
Components	a	b	a b	a b^2	c	a c	a c^2	b c	a b c	a b^2 c^2	b c^2	a b^2 c	a b c^2
	Group 1	Group 2			Group 3								

Fig. of interaction between two columns ($L_{27}(3^{13})$)

	1	2	3	4	5	6	7	8	9	10	11	12	13
(1)		3	2	2	6	5	5	9	8	8	12	11	11
		4	4	3	7	7	6	10	10	9	13	13	12
(2)			1	1	8	9	10	5	6	7	5	6	7
			4	3	11	12	13	11	12	13	8	9	10
(3)				1	9	10	8	7	5	6	6	7	5
				2	13	11	12	12	13	11	10	8	9
(4)					10	8	9	6	7	5	7	5	6
					12	13	11	13	11	12	9	10	8
(5)						1	1	2	3	4	2	4	3
						7	6	11	13	12	8	10	9
(6)							1	4	2	3	3	2	4
							5	13	12	11	10	9	8
(7)								3	4	2	4	3	2
								12	11	13	9	8	10
(8)									1	1	2	3	4
									10	9	5	7	6
(9)										1	4	2	3
										8	7	6	5
(10)											3	4	2
											6	5	7
(11)												1	1
												13	12
(12)													1
													11

(1)



(2)

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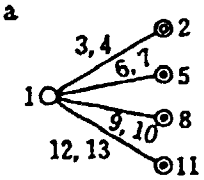

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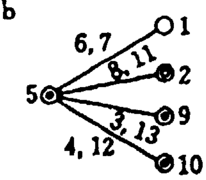
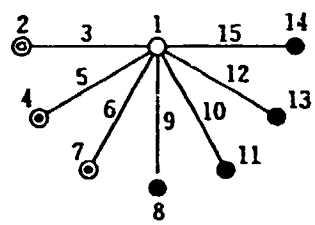
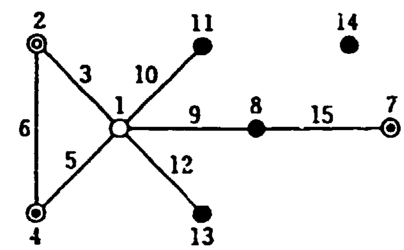
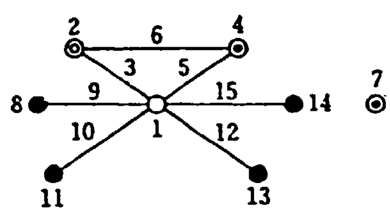
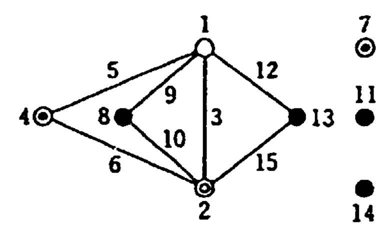
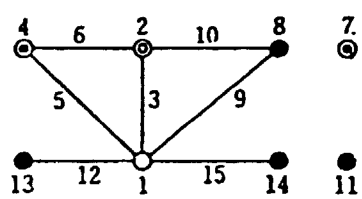
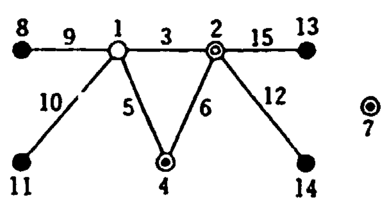
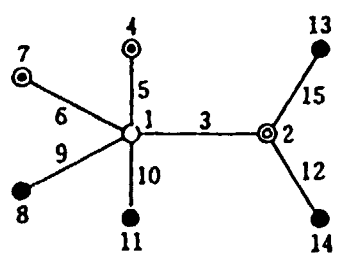
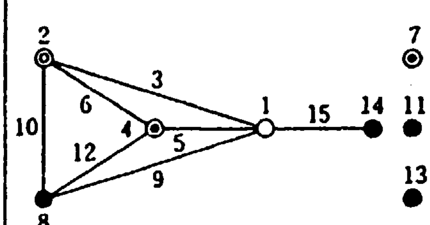
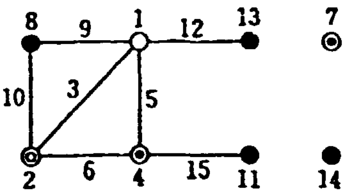
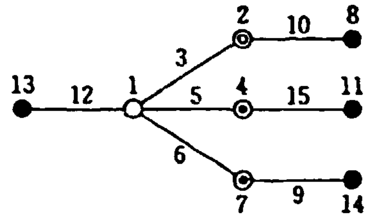
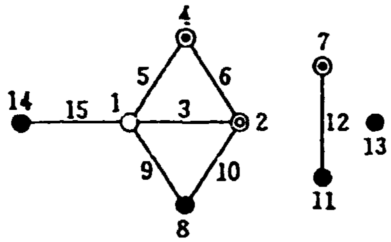
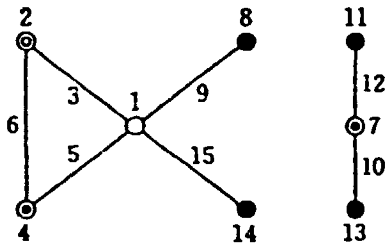
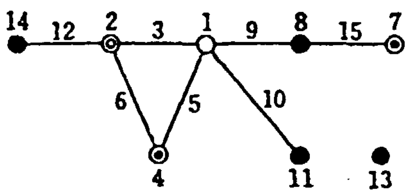
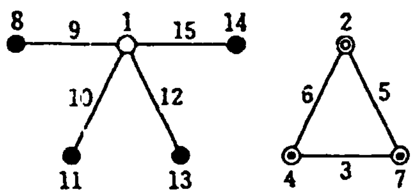
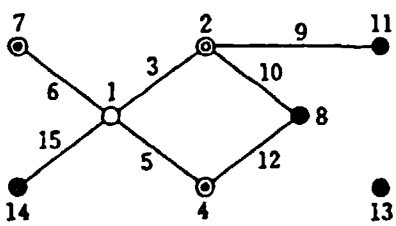
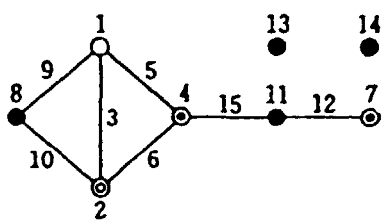
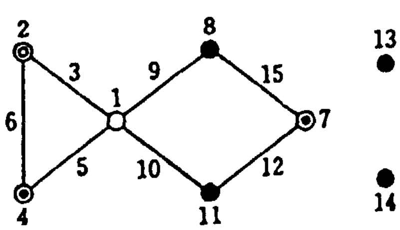
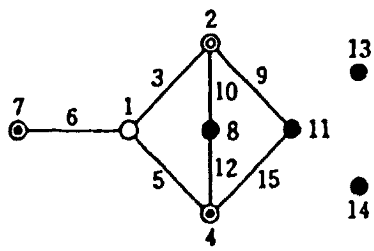


Attached Fig. 6 Line-and-dot diagram for Resolution IV

Note 1: When the number of factors is 8, 26 types in the following diagram are available.
Note 2: When the number of factors is 7, 17 types with * mark in the following diagram are available.
Note 3: When the number of factors is 6, 7 types with ** mark in the following diagram are available.

Type No. Pattern	Line-and-dot diagram	Type No. Pattern	Line-and-dot diagram
1 (71111111)		5 (52221110) *	
2 (62211110) *		6 (44222000) *, **	
3 (53221100) *, **		7 (44211110) *	
4 (53111111)		8 (43331000) *, **	

9 (43321100) *, **		14 (42221111)	
10 (43221110) *		15 (42221111)	
11 (43221110) *		16 (42221111)	
12 (43221110) *		17 (33322100) *, **	
13 (42222200) *, **		18 (33322100) *, **	

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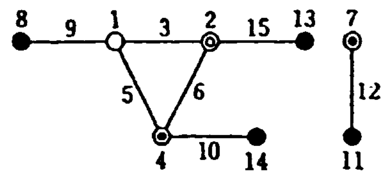

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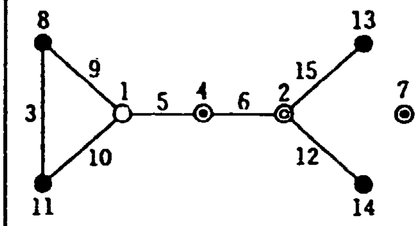

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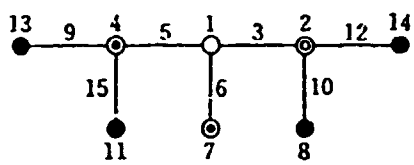

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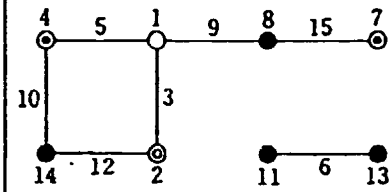

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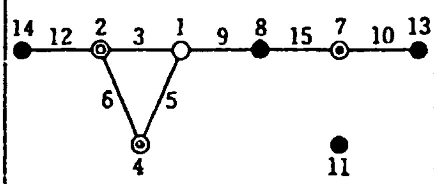

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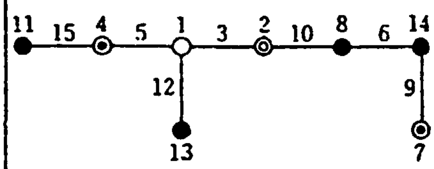

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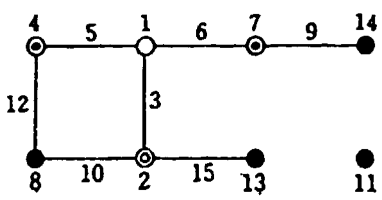

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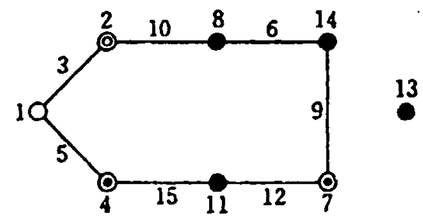

Marketing for Continuous Improvement

-Product Planning Seven Tools-

by Noriaki Kanda

CONTENTS

"Seven Product Planning Tools" for New-Product Development

Noriaki Kanda
Professor
Faculty of Economics, Department of Business Administration
Seijo University

1. Introduction

During the 58th Quality Control Symposium, which met in Hakone as June 3 and 4, lively discussions took place under the theme "TQC as Helpful to Corporate Management." Most impressive among the discussions, and what made the author consider an urgent issue, was that the participants strongly requested TQC experts to make new proposals for:

(a) a method to formulate strategies and

(b) a method to plan new products

so that TQC could better serve the interests corporate management. This was because the author who engages in studies of business administration, is responsible for both of these requests, and because (b) is the very subject he has studied for several years through the TQC research group (TRG) organized by the Union of Japanese Scientists and Engineers (JUSE).

During the past four years, by forming several working groups with the cooperation of JUSE, TGR members have researched possible proposals for TQC in an new age. In his lecture at the symposium, Yoshinori Iizuka, TRG representative manager and Assistant Professor at the University of Tokyo, introduced these research efforts as well as the first open symposium, scheduled for June 25 organized by TRG. Recently, increasingly loud cries have risen for a TQC reform. Hakone symposium participants too expressed their earnest wishes for such a reform. At the time of this writing, the author does not know how the symposium on June 25 was rated; and the author, who made presentations at it, is waiting almost fearfully for the results.

Assistant Professor Iizuka once said, "Let's take sides with the victims criticism instead of those lavish it." The remark was quite witty. It presents a slogan which would be most welcome in today's TQC community. Currently, corporate executives cannot afford to rely on their past performance results. If these executives look at the QC community calmly, they will find that in recent years no outstanding new products have been developed. They will also find that even the concept of quality has been threatened by TPM and has grown less fit for today's age of high quality. In short, TPM has become unreliable.

2. TRG's working group and seven product-planning tools

Under the circumstances, TRG's Working Group (WG) on product planning and marketing, including the author, has held a study meeting once a month for the past two years. Stafffed by excellent young researchers with a distinct personality, WG has been enthusiastic in trying to propose helpful new tools by any possible means. In doing so, it partly struggled but also enjoyable. All the members were highly knowledgeable in QC, and moreover, interested in marketing and creative methods. They had entertained a strong feeling of dissatisfaction with the present status of the QC community. At first, they merely discussed their feelings candidly. But through study meetings on marketing science, reports by the author on his interviews with corporate representatives, lectures by invited speakers from the realm of irivate enterprise, and numerous other discussions, (the author believes that) they came to have a common understanding of the following points:

(1) The discipline of marketing contains methodologies for developing new products, but various available ideas and methods are not systematized.

(2) Marketing science has achieved remarkable progress, and the major results valuable hints to the WG members .

(3) Conversely, researchers in marketing circles know too little about QC methodologies. While researchers both in the marketing and QC communities have a common objective of providing products that meet consumer needs, their discussions deviate widely.

(4) QC researchers should fully recognize the effectiveness of QC methods, particularly statistical quality control (SQC) and quality function deployment (QFD), and they should use methodologies more fertile than traditional ones in developing new products, particularly in the initial stage.

(5) WG should propose systematizing methods for planning new products by combining marketing and QC methods, and providing those selected from the combined methods as an "ideal series of methods."

Against this background, WG chose, and intends to propose, the "seven product-planning tools." It would like senior researchers to permit their calling the tools "P7," in short by taking "P" from "planning." Particularly in marketing, a great many tools can be a candidate for admission among the seven tools. WG has therefore sorted out candidates and picked the seven tools according to the following policies (detailed descriptions shown in Section 6):

(1) To select a representative, general-purpose tool for each planning step

(2) To intentionally select two tools in areas, such as the conception method which is proposed by many but has been used less broadly than expected (and whose broader use is hoped for)

(3) To propose a sequence of tools that should be used according to the (ideal) planning steps, instead of listing them at random. Product planners, however, should not be forced to use them in a proposed

sequence. Unnecessary standardization should be avoided because products vary in character and corporate policies differ.

But it took a long time before discussions reached a final conclusion. After dismissing a number of conclusions several times, WG settled on the tools introduced in this article. During this period, WG members made preliminary presentations at a TRG managers meeting and the second TRG workshop. In addition, WG received positive suggestions from the editorial committee of this magazine. All of these gave WG opportunities to make improvements in selecting the tools. Its members would like to express their sincere gratitude to the parties concerned.

Unfortunately, P7 is still not powerful enough when compared with the seven QC tools (Q7) and the new seven QC tools (N7). It is a duty and a privilege of young researchers to dare to promote overall progress by making proposals and receiving criticism even though such action might be reckless. The editorial staff and each author would appreciate the readers' frank comments and criticisms of this series, which will last until December. WG members do not think that P7 is perfect, hence are willing to propose their second and third versions in the future. Although this selection is called the seven tools, some of them are actually a collection of two or more tools. A closer look will reveal that the seven lack unity and are not sufficiently defined in terms of the scope of application. WG will strive to improve them in its own way. Meanwhile, experimental and analytical tools, including positioning and conjoint analysis, as well as various types of conception sheets for the conception method, and a tool also used in presenting ideas by automatically converting and combining their attributes, can be easily computerized. If available software can automatically prepare questionnaires using databases, it would be highly convenient. Development of such software has become indispensable to dissemination of the methods. Therefore, participation in WG and cooperation by anyone interested in this software development are hoped for.

The following members of TRG's Working Group on product planning and marketing are scheduled to contribute to the series of articles in this magazine after August. The titles are tentative.

Noriaki Kanda
Seijo University Faculty of Economics
"Group Interviews and Surveys Using Questionnaires"
(August issue)

Shinya Nagasawa
Asia University Faculty of Business Administration
"Positioning"
(September issue)

Tsutomu Konno
Yamaha Motor Co., Ltd. Production Management Division
"Conception Method"
(October issue)

Shinichi Okamoto
Tokyo University of Information Sciences Faculty of Business Administration and Information Science
"Conjoint Analysis"
(November issue)

Tadashi Ofuji
Tamagawa University Faculty of Engineering
"Quality Charts"
(December issue)

3. Hint 1 for P7: Survey of product planners

Last year, to grasp the actual status of product planning, the author had opportunities to visit four companies specializing in planning and research and three manufacturers to interview their personnel who work at the front line of planning. The author wishes to heartily thank these firms for their cooperation. The questions the author asked focused on the following five points:

(1) Are planning processes standardized?

(2) Purposes of conducting market research, and their content and analytical methods

(3) Are there any particular methods used for conceiving ideas as well as points to note in this relation?

(4) What process is used to narrow down concepts?

(5) Do interviewees know about conjoint analysis or are they using it?

Not many companies were surveyed, and this poll concentrated on those retaining professional planners which specialize in surveys and planning, rather than manufacturers. As far as the author understands, however, this survey seemed to provide a rather general picture of product planning practices at companies.

The replies that the interviewees gave the author cannot be publicized, but because the author was fortunately able to receive several hints, he would like to list them as follows:

(a) Few companies have well-standardized planning processes. It is natural that planning processes vary according to the nature of products or whether products are developed anew or by improving existing ones, but having no standardized planning processes presents a problem. The author wishes to standardize planning processes. In the manufacturing industry, most of the post-design processes are systematized but it is not clear whether planning processes are systematized.

(b) No particular conception methods are used (except at least the brainstorming variety). There are certain cases in which conception methods are studied and used by an individual. The author would like those individuals to study good methods and tell him about them.

(c) Inquiring about or actually studying the scenes of life is a highly effective method. Opinions of family members and friends are also instructive. Group interviews present a good method.

(d) Market research using questionnaires is conducted to verify hypotheses. In general, identifying consumer needs becomes difficult since market research is not allowed to end in failure or be repeated owing to the expense and time involved. Market research is conducted to obtain firm evidence to prove the validity of a certain hypothetical scenario.

(e) Planners often experience trouble when narrowing down concepts. When producing a prototype, a method for its evaluation and modification by showing it to several individuals is used. Conjoint analysis shortens this process, enhancing efficiency.

(f) Planning and research companies are already using conjoint analysis or else they wish to. But the method is not yet familiar to most manufacturers. Those firms that currently use the system rate it highly and plan to apply it more widely.

4. Hint 2 for P7: Integration of marketing and QC

What image does the term "marketing" bring to mind among readers who are not very familiar with it? The term "QC" brings to mind among those engaged in other fields the following images:

Dark, regulations, troublesome, difficult, statistics, small-group activities, manufacturing sites, inspection, and technology-oriented

All these images are slightly negative and rigid, and inclined toward manufacturing. "Marketing" brings to mind the followings:

Bright, aggressiveness, sales strategy, advertising and publicity, distribution, and sales-oriented

These are slightly showy and positive images. At universities, the subject of QC is associated with engineering while that of marketing relates to business administration or commerce. As some compare QC and marketing to "water versus oil," they have been considered as foreign to each other. Actually, both have something in common in many ways. Specifically, both:

(1) Aim at meeting customer needs

(2) Are a system of means that aims at practice

(3) Often use statistical methods (particularly modeling methods, including multivariate analysis)

(4) Have areas they cannot easily address, such as management strategy, accounting and finance, and information processing

In particular, marketing science is based on statistical methods as SQC and has much in common with it.

Conversely, they differ from each other in the following respects:

(1) In marketing, emphasis is placed on development of new products and exchange processes, such as distribution, sales and

advertising, while QC streses overall policy management and design and manufacturing processes.

(2) In marketing, many issues relate to techniques peculiar to its activities, while in QC, many relate to general techniques for resolving problems.

(3) Marketing does not aim at company-wide activities, while QC does, with total workforce participation under a slogan of "quality". If the two were integrated, clearly they would supplement each other, covering all processes from development to manufacturing and sales.

5. What is needed in planning new products

Even if the goal is integration of marketing and QC, methodologies will vary depending on what sort of product is considered as ideal when developed.

Two kinds of product classification based on the author's view are shown in Figs. 1 and 2. In Fig. 1, the axis of abscissa represents the level of expectation before the purchase of a product and relates mainly to information available on the product, such as advertising and publicity, word of mouth, corporate image, and so forth. As the product moves farther to the right, it means that the expectations held for it grow higher. The axis of the ordinate represents evaluation after purchase of the product, which is largely determined by a balance between its quality and price. The product's moving farther upward means that it is rated more highly. A product located in area A is one that is as excellent as expected, and could be called a "product that is as good as we thought, after all." A product originally located in area B can often move to area A owing to the effects of word-of-mouth communication and publicity. A product in area D has drawn a negative rating in spite of expectations. Many of the readers may have had an experience of being disappointed with a product after being allured by its exaggerated advertisement and purchasing it. This is a "disappointing product after all." If consumers are successively palmed off with such products, these products will gradually lose consumers' trust and as a result, move to area C where products are not expected from the beginning. A product in area C is one that is called a "disappointing product as expected" because it is of inferior quality exactly as expected. This is the worst of all. Obviously, consumers buy products either in area A or B; in other words, it is important that they are of high quality and low-priced. Products in area C and D are not likely to be purchased again.

In Fig. 2, the axis of abscissa shows whether an idea is good or bad, while the axis of the ordinate represents consumer needs as high or low. A product in area P is a hit because, as in VTR cameras with a built-in TV set, its idea is original and has met general consumer needs. A product in area Q is one that has become popular and common as in beer with a dry taste, or one that has originally been targeted at this area as a popular car.

A product in area S is one whose idea is original but does not sell much because it is designed to meet special consumer needs. However, it can move to area P once it is widely recognized and then meets potential consumer needs. A product in area R is of a minor importance.

In this article, the goal is products in P. Products that lack original ideas are imitations, and in the long run, they will degrade the corporate image of their manufacturer and reduce its market share. If emphasis is placed on a narrow scope of consumer needs, high sales cannot be expected.

Based on the foregoing studies, important points in product planning are summarized as follows:

(1) To aim at high-quality products. However, evaluation of price should be included in the planning process because quality is evaluated in comparison with price.

(2) Desirable are products that are novel and meet a wide scope of consumer needs. However, it should be noted that the scope of consumer needs that they are designed to meet may be unknown because consumers may not perceive their own needs at first.

It might be no exaggeration to say that, of the four important points, i.e., identification of consumer needs, original ideas, high quality, and relatively low price, QC has been virtually involved only in high quality. In other words, the other three have to be addressed anew. Therefore, the following methods will be needed:

(a) Method for identifying consumer needs:

Needs that consumers can tell instantly when asked are no longer the focus of competition. How can such latent needs as "can be recognized only when one is told" be identified? Group interviews will be one of the solutions.

(b) Method for developing concepts:

Even if consumer needs are identified, how can a concept be developed that can meet their needs? Furthermore, the concept is required to be original. Idea development methods are needed here, too.

(c) Method for determining the optimal concept (including price):

Various products can be developed by making changes on a concept. Price has major effects on what concept should be used, so ultimately, there is no other way but to ask consumers. Conjoint analysis will be effective.

Fig. 1. Diagram of expectation and evaluation levels
Positively evaluated after purchase
Negatively evaluated after purchase
Highly expected before purchase
Least expected before purchase
A: Product that is as good as expected
B: Product that is unexpectedly good
C: Disappointing product as expected

D. Disappointing product after all

Fig. 2. Diagram of originality and ordinariness
General consumer needs
Special consumer needs
Ordinary
Original
P: Hit products
Q: Regularly popular products
R: Products that do not sell
S: Original products

6. The seven product-planning tools

Against the backdrop of necessities as described above, the seven product-planning tools have been selected and combined. Fig. 3 shows the sequence of their uses, together with a recommended general product development process. Other traditional methods, including SQC, which can be effective when combined are also shown in the diagram.

As mentioned earlier, this is not a perfect version. In addition, it is not necessary to use the seven tools exactly in the order shown in the diagram or to use all of them. It is enough to use necessary tools when one wishes to. The dogmatism of QC does not suit a job like product planning that differs from company to company and from product to product.

For example, we often see a method whereby ideas are first presented, then screened through surveys. The subjective positioning of a product may be analyzed first, followed by surveys based on the result of such analysis. A clear product concept may naturally evolve without idea development methods and conjoint analysis. However, corporate product planners should standardize the sequence of planning processes, at least according to product classification, and keep in order the methods used.

The outline of the tools is listed in Table 1, and detailed descriptions will appear in the issues of next month and thereafter.

Fig. 3. Flow of product planning and the seven tools
< Development steps >
Identification and study of consumer needs
(1) Identification of needs
(2) Verification of needs
(3) Study of needs using product diagrams
Establishment of a concept
(4) Development of concepts
(5) Testing of concepts and determination of the optimal concept
Design, production of prototypes, and evaluation
(6) Linkage of the concept with design

(7) Design
(8) Production of prototypes and evaluation
(10) Market test
(11) Production and sales plans
(12) Mass production and sales
(13) Study of market evaluations

< P7 >
1. Group interviews
2. Surveys using questionnaires
3. Positioning
Idea development methods
4. I. Idea development check lists
5. II. Tabular idea development methods
6. Conjoint analysis
7. Quality charts
1. Group interviews
2. Surveys using questionnaires

< QC methods recommended for joint use >
??Affinity charts?? and ??linkage charts??
Multivariate analysis
- Factor analysis and principal component analysis
- Cluster analysis
- Quantification method
- Multiple regression analysis
- Discrimination analysis
- Multidimensional scaling (MDS)
New seven QC tools
- ??Affinity charts??
- ??Linkage charts??
- Systematic charts
- Matrix charts
Various idea development methods
- Brainstorming
- NM method
- Key needs method
- Others
Design of experiments
Quantification methods I and II
Quality function deployment
SQC methods
- Multivariate analysis
- Design of experiments
- Reliability engineering
Multivariate analysis

<Related jobs >
Gathering of various information
- Opinions of customers and sales channels
- Analysis of hit products
- Information from mass media
- Information from specialized magazines
- Surveys of the actual condition of consumers' lives and their use of products
- Surveys of internal seeds of product planning
- Surveys of external technological trends
Study of technological development possibilities
Assessment of economic efficiency
Development plans
Technological development
Production planning
Cost planning
Sales planning
Reliability planning
Technological evaluation of prototypes
Establishment of production technology

Table 1. Purpose and outline of the seven tools (P7)

No.
Methods
Main purpose
Outline

1
Group interview
To identify consumer needs - To examine what is needed
- Consumer needs are identified by having several (five to six) representative consumers freely talk about the actual condition of their lives and use of products, the features of goods which have disappointed them, and their requests regarding the products.
- Group interviews do not cost much.
- Group interviews can be applied not only to develop hypotheses but verify them qualitatively as well.
- Group interviews represent a typical qualitative survey method. But care is needed when making preliminary plans, selecting participants and a competent moderator, and analyzing linguistic data.
2
Polls using questionnaires
To verify consumer needs - To examine whether consumers truly need

- Replies are collected from a large number of consumers to quantitatively verify hypotheses developed through group interviews.
- Opinions freely expressed by polls may provide unexpected hints.
- Surveys using questionnaires are costly since several hundred replies are usually required.
- Polls using questionnaires constitute a typical quantitative survey method. But care is required when determining questions and options for reply as well as linguistic expressions.
- One must be precise in selecting target groups and sampling those who are surveyed.
- Meaningful information can be obtained only through excellent analytical ability. In particular, multivariate analysis is suitable for the positioning and clustering of products as well as for factor analysis of customer satisfaction.
- Questionnaires should be designed after the flow of analysis is determined.

3

Positioning

To model the relationships among products - To examine the relationships with other products and identify possible niche markets

- Relationships among products are clarified and examined by using data obtained through surveys and by plotting them in the product positioning map. The scale of evaluation along the axis of abscissa and the axis of the ordinate may be determined subjectively.
- Generally, multidimensional assessment scores for several products are processed by factor and principal component analysis methods, and the average values obtained are used. Quantification theories III and IV and multidimentional scaling (MDS) are also useful. Cluster analysis can be used for classifying products.
- A vacancy in the product positioning map means that there are no products that represent a concept corresponding to the vacancy, suggesting the possibilities of developing new products.

4

Idea development check list

To develop ideas exhaustively and without omission

- Osborn's checklist is a convenient way for planners to learn for themselves whether they have developed ideas exhaustively and without omission, and to give them hints on how to form diverse ideas.
- The checklist comprises of nine major classifications: (1) Are there alternative uses for a product? (2) Can it be applied to other purposes? (3) How about modifying it? (4) How about enlarging it? (5) How about reducing it? (6) How about replacing it with something else? (7) How about re-arranging it? (8) How about reversing it? (9) How about combining it with something else? These classifications are subdivided into smaller items.

5

Tabular-format idea development method
To develop ideas using tabular format - To develop original ideas efficiently
- Various idea development methods are easier to use if put into tabular format. Several typical idea development methods are expressed in a unique format.
- The combination idea development method is one in which planners analyze the situation and attributes of issues and combine them to form new ideas.
- The analogy idea development method is one wherein planners find solutions to problems by seeking analogies from the status of issues or the reverse situation thereof.
6
Conjoint analysis
To optimize concepts - To establish the image of products in specific terms
- Concepts are expressed by combining various product attributes, such as size, color, shape, material, functions, price, etc. What the attributes are, how they affect consumer preference, and how they can best be combined are verified through experiments using consumers.
- In case a product has many attributes, knowledge of the experimental design method is useful because levels of attributes are assigned using orthogonal tables.
- It is desirable that concepts be assessed using a life-size prototype but usually it is difficult to produce one. Therefore, cards with illustrations and descriptions are prepared for each combination of attributes.
- If characteristic values are evaluation scores measured in the form of continuous data, they can be studied by variance analysis, multiple regression analysis, and quantification theory I.
- In general, ordered data (ranked according to preference) are used to model the usefulness of the attributes so that the order can be reproduced.
7
Quality charts
To link concepts with design - To translate concepts into quality characteristics
- A long way to go in the design process even if a concept has been clearly defined. In order to translate a concept into a specific product, we recommend making effective use of the quality function deployment method, particularly quality tables, more than anything else among the QC tools.
- Use of quality tables enables translating clearly and successfully the results of studies hitherto made into design quality.
- Previously, the relative importance of each of the required quality characteristics was not necessarily clarified. Conjoint analysis and other methods enable expressing quality characteristics numerically to a considerable extent, enhancing efficiency and accuracy. (Note: It is

difficult to determine all attributes precisely through conjoint analysis, and not all quality characteristics that should materialize the attributes can be clarified.)

7. Conclusion

In an age during which many enterprises devote all their energy to development of new products and hit products, we find an unexpectedly large number of firms that still use a planning system or method based on KKD: kan (intuition), keiken (experience), and dokyo (determination). Meanwhile, strong opinion has it that traditional QC methods are difficult to know well. One solution is to introduce information equipment, but it will not solve the problem immediately. The author and his fellow researchers believe that they have more or less developed standard, recommended product planning tools and the sequence of their use in their own way, but we admit to being only 60% confident. We wish to improve the tools together with our readers in the future by verifying them through case examples, developing related software, and the like. We would be most pleased if the readers would take a long and understanding view of our trials and errors.

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SEVEN TOOLS FOR NEW-PRODUCT PLANNING
--- Integration of TQM and Marketing

Noriaki Kanda
Professor
Business Administration Department
College of Economics
Seijo University

1. What are the seven product planning tools (P7)?

On June 25 last year, the First TRG Symposium was held under the sponsorship of the Union of Japanese Scientists and Engineers (JUSE). The TQC Research Group (TRG) was organized at the initiative of JUSE and consists of young and middle-aged researchers. Under the leadership of Yoshinori Iizuka, Assistant Professor at the University of Tokyo, it aimed at researching a new form of TQC. Its research covers methods for implementing TQC, strategy and policy management, reliability, process control, and the like. Its working groups include one for product planning and marketing, for which the author serves as manager. The other four members of this group are (in alphabetical order):

- Tsutomu Konno, Systems Design Institute
  (then Yamaha Motor Co., Ltd.)
- Shinya Nagasawa, Ritsumeikan University Faculty of Business Administration
  (then Asia University)
- Tadashi Ofuji, Tamagawa University Faculty of Engineering
- Shinichi Okamoto, Tokyo University of Information Sciences
  Faculty of Business Administration and Information Science

Based on studies of marketing, the working group aimed at making effective proposals on the issue of product planning, an area in TQC that many hope will be strengthened or restructured (but is difficult to accomplish under the present circumstances). With this aim, the group engaged in open and heated discussions from month to month. Even before the group was organized, though, the author intuitively felt the futility of merely proposing theoretically effective methods for product planning at random. The author then presented the original version of the current seven tools at closed sessions of the TRG workshop. His reasons were:

(1) Marketing methods are unfamiliar to people not only in the technological field but in the clerical field as well.

(2) Marketing methods cannot be used effectively unless limited to representative examples. The same applies to statistical quality control (SQC) methods. Even a small number of marketing methods can have

full impact, and the author wants to make them much more effective than before.

(3) It is easier to propose methods by arranging them in sequence together with product planning processes than to list them at random.

Thus the working group started with the author's original version. While following the example of the seven QC tools (Q7) and the new seven QC tools (N7) which senior researchers assembled, the working group collated the original version into seven tools. After lengthily discussion, the group finally completed the "Seven Tools for New-Product Planning" and called them simply P7. Discussions were quite arduous, and it was not easy to settle on the seven tools. Criticized by, or receiving suggestions from, people outside the group, the working group considered the tools several times over. Fig. 1 shows the final version of the seven tools.

The term "product planning" used here is not a concept that embraces the entire process of product development, rather it refers to part of the sequence, from finalizing a product concept and relaying it to the design process. As shown in Fig. 1, P7 is roughly divided into the following four groups:

(1) Survey methods for identifying what consumers need and want and also determining the direction of product planning in qualitative and quantitative terms. They include (a) group interviews, (b) surveys using questionnaires, and (c) positioning analysis.

(2) Idea development methods for developing original and attractive concepts. They include (d) an idea development check list and (e) the tabular-format idea development method

(3) Optimization methods for determining the optimal concept that will meet the expectations of consumers while maintaining a balance between price and quality. They include (f) Conjoint analysis

(4) Linkage for connecting finalized concepts with design. They include (g) quality charts.

Descriptions of each method are given in literature (2) and (3) listed in the bibliography. Refer to literature (4) to be published this autumn for more detailed descriptions. The author does not intend to explain these methods roughly and hastily in this article because the description of most of them requires a considerable amount of space. Unexpectedly, P7 was well received at the TRG Symposium last June. After that, the author explained it in the above-mentioned literature and it was exposed to the eyes of many readers. Meanwhile, the author gave a lecture in many places as part of his efforts to publicize it. In about a year, he explained it before 16 lecture meetings and symposia held at societies, associations, companies, and universities, including the Quality Month lecture meeting at Kobe in November 1994 and the meeting of the Japanese Society for Quality Control in Tokyo in May 1995. Although he feels that there is still a long way to go, the author deeply appreciates the support given at these meetings and symposia.

Since a number of arguments and questions arose during this period, the author wishes to sort them out in Section 2 and make them serve as a basis for further development of P7. In addition, the current trends and future outlook of P7 are described in Section 3.

Fig. 1. Outline of the seven tools for new-product planning (P7)
Surveys
(a) Group interview
(b) Survey using questionnaires
(c) Positioning analysis
Idea development
(d) Idea development method I: Idea development check list
(e) Idea development method II: Tabular-format idea development method
Optimization
(f) Conjoint analysis
(g) Quality chart

2. Topics and studies of P7

In this section, using a Q&A format, the author wishes to answer the several questions that were posed at the lecture meetings and symposia and also make supplementary comments.

(1) Do persons in the technical field lack an aptitude for planning?

As Mr. Kuniaki Takashima of Isuzu Motors Ltd. points out regarding this, persons in the clerical field are good at market research, and when in charge of planning they are able to make clear assertions on the basis of consumer data. By contrast, persons in the technical field inevitably tend to regard matters from the standpoint (moreover, the current level of technology), rather than from the viewpoint of consumers. It may be unavoidable that their first thoughts turn to whether they can make a particular product, or can achieve a technological breakthrough, and if a particular experiment is difficult. These long-standing habits are hard to shake off even if they are currently away from the job of research and development or design. Moreover, many of the manufacturers in Japan have competed in terms of how excellent products they can produce and how quickly they can produce them rather than in terms of marketing skills. As a result, they have given priority to technology in planning. They have only recently started to place emphasis on bold and novel ideas.

When the author talks with company employees in clerical positions or students majoring in liberal arts, he feels that because they are what is known as scientific or technological experts, they are broad-minded and have a wide range of freedom in their personality. They are also sensitive to the socioeconomic trends and good at communicating with others. In addition, they are fashionable and have a strong desire to eat tasty food.

This is partly because they include a relatively large number of women. For their part, persons in the scientific and technical fields do not care about their plain and stained clothes if the author is allowed to generalize in describing them (the author understands them quite well because he, too, somewhat feels that he was formerly one of them). They are also satisfied with a students' dining room or family restaurant. In addition, they lack sensitivity and ideas, and they have a feeble sense of living and being part of society.

Fig. 2 describes the types of company employees according to age, sex, and professional field though the descriptions may be rather extreme.

If planners at a company consist only of (a) middle-aged and old persons, (b) technology-oriented persons, and (c) males, the company had better reconsider such a personnel arrangement as soon as possible. This may not apply to every product, but will clearly serve as a criterion. Making things that make the utmost of the sensibility of the times starts with creation of a planning environment or organization.

Fig. 2. Types of company employees
Clerical field
Middle-aged and old
Technical field
Young
Female
(Word-dominated types)
Snappish
(Introverted types)
Reserved and hesitant
(Flexible types)
Loose and slack
(Curious types)
Excited

(2) P7 includes SQC methods. Can a person not understand it unless he or she majored in science and technology?

The question represents groundless anxiety. Actually, students at attending the seminars at which the author spoke major in liberal arts, and all of them have analyzed the results of surveys using questionnaires via the multivariate analysis method that reputedly is so difficult. The regularly use such means as multiple regression analysis, quantification methods I and II, and factor analysis, and have become quite popular. Positioning analysis is also easy for them. No instruction has been given in conjoint analysis but it will not be difficult for them. However, it is generally hard to make them fully understand these methods through numerical formulas. It is also essential to make all calculations using computers so they can more readily grasp these methods (this also applies to students majoring in science and technology). In short, one need only to educate students carefully and earnestly. Too, since it is more important for students to master to fully understand these methods, it is advisable to give them comprehensive training by encouraging the writing of a report or thesis on the subject they have surveyed and examined by themselves. Studies often used in liberal arts, such as bibliographical type, are all but useless in this kind of training because most of them result in were desktop theory.

Persons who have majored in science and technology, particularly those who learned SQC methods accurately, are especially, quick in comprehending these methods. But it remains as a task of a different dimension to recognize the standpoint of consumers, and to make surveys, analyze the results, and develop ideas using the language of consumers. It is unavoidable that they have not frequently conducted qualitative and linguistic processing and analyses.

As mentioned earlier, planners must have a wide range of abilities. It is not desirable that their skills be limited to particular fields. As applicable to the previous item (1), when arranging planning personnel, those who have specialized in liberal arts or technology should be numerically well balanced.

(3) Should P7 be applied only to planning new products?

Needless to say, P7 is effective in planning new products, and it was originally developed for that purpose. The question remains as the whether it can be applied to planning products by improving existing ones. When it comes to product planning, there are not only cases wherein new products are developed; there are also many instances of planners wishing to improve existing products, as a means to differentiate them from those of competitors . If the author states his conclusion, the obvious answer is yes. However, methods generally used would be different. For example, Sharp Corp. became famous for planning unique new products, but the firm's efforts to improve existing products also deserve praise. The company qucleses a questionnaire in the package of each of its products and seeks guidelines for improvement by developing portfolio-evaluation models in relation to customer satisfactions levels through multivariate analysis. This approach represents quantitative analysis that stresses not group interviews but surveys using questionnaires. Planning products by improving current models is characterized by easily evaluation in specific terms because the products are already in existence. In this kind of planning, quantitative methods such as polls using questionnaires, positioning analysis, and conjoint analysis would be more effective.

As for concept development, idea development check lists in which planners can start evolving an idea on the basis of products or technologies plus the seeds concept development method, which will be mentioned later, provide valuable hints for improvement.

(4) Is P7 only for the manufacturing industry?

There is no such intention. The reason the author calls P7 tools not only for manufactured-product planning but also for product planning is that he intends to make P7 applicable, as well, to planning in the service industry (one in which planners do not say "manufactured-product planning"). For example, when planners at a restaurants develop a new menu, those at a department store plan toward creating a place with a new image, or those in an insurance company plan their new , they start by conducting group interviews in which they listen to assorted opinions and ended by determining the direction of planning through surveys using questionnaires. A series of the methods they use can produce results without fail.

Idea development methods provide planners with novel ideas, and conjoint analysis lead them to make optimal decisions that meet the expectations of customers in terms of balance with price.

(5) Is P7 suited for consumer goods but not fit for producer goods?

Many producer goods are supplied on the basis of orders placed by companies and the anticipated number of orders. In such cases, there is a tendency that such exploratory methods conducted in a vague situation, as group interviews become unnecessary. This tendency does not pose a problem with, however. It is not economical to think that such methods will or should accomplish everything. Systematic surveys using questionnaires on consumer assessment of products and their levels of satisfaction with service systems provide valuable feedback for further improvement. Moreover passive companies that merely wait for orders cannot adapt to today's rapid economic changes and will be weeded out. Enterprised must continuously develop technologies and actively market products based on original ideas. To that end, idea development methods are extremely helpful. Conjoint analysis may be somewhat difficult to conduct, as it demands customer cooperation. But information on how the consumer gauges the balance between quality and pricing that have been examined and proposed to them is extremely important. Thus such cooperation should be sought by all means.

(6) Is P7 unnecessary for small- and medium-size enterprises?

More than 90% of all firms in Japan are small- and medium-scale operations, and it is well known that these companies are brimming with original ideas and more vigorous than large enterprises. In general, though, small- and medium-scale firms do not have established planning methods. In extreme cases, they plan their products solely on the basis of the personal skills of their president or a limited number of employees. A president full of original ideas is fine, of course, but companies like his should have an established system featuring employees capable of planning products. If not, they are apt to face a crisis regarding survival, even bankruptcy, should an emergency arise.

The problem is, that SQC methods must be used. A person should not be daunted by them. Rather, a person should start with what he can do and confirm the effectiveness of these methods first. If one becomes willing to use more of them and is aware of the need for the entire range of SQC methods, he may well start to gradually increase the number of SQC methods practiced. It is recommended that first of all, a firm applies development methods that will bring instant results. Likewise, QC circle members start by learning about only Pareto diagrams and characteristic diagrams, two of the tools that comprise Q7, then use the other tools one by one. The author hears that recently they have used many example of N7. He hopes that planners will not be hasty when using SQC methods.

(7) Can P7 be used for business planning or sales planning?

Because of their nature, fonnulatius corporate business strategy clearly is beyond the capacity of the P7 methods, but depending on the nature of planning part of them can be applied. For instance, when a company plans to engage in a new business undertaking, market research is necessary to assess how promising the endeavor is. Thus consumer surveys using questionnaires are indispensable. Positioning analysis is helpful in examining the relationship between the firms new business and existing business as well as between its new business and the businesses of other companies (it need not be quantitative). Idea development methods are also useful in creating unique businesses.

Because advertising planning is similar to product planning, group interviews, idea development methods and conjoint analysis enable planners to make original and optimal plans. Polls using questionnaires are needed when conducting studies on basic product images. Similar tactics can be applied in sales planning but, traditionally, planners base their work mainly on past experience and do not practice basic analytical methods. P7 enables planners to be objective and view things more from the standpoint of consumers. Group interviews involving consumers, retailers and wholesalers are effective. Depending on which of these methods are more easily accepted, conjoint analysis can be applied. The author hopes that such means as surveys using questionnaires and positioning analysis will be practiced faithfully. If by practicing SQC methods (or, rather, multivariate analysis) one becomes able to discover the relationships among various data, grasp factors objectively and make forecasts, he will receive enormous benefits though it may be difficult to master the methods.

(8) It would seem to cause a lot of trouble if all the tools are used in this order.

It is only natural that a certain amount of time, money and labor be applied. New costs are incurred because what should have been done had been neglected. This is similar to a situation in which companies undergoing an examination for the Deming Prize have trouble in documentation work. However, once these tools are systematized in a decisive manner and experience repeated use, planners come to understand which of the tools are unnecessary and revision or improvement for their company. In this manner, a truly efficient planning system can be established. Once it is, there will be fewer and fewer irrelevant products, and this decrease will be of great help in the long run. This is similar to a situation wherein, though the introduction of QC is troublesome at first, it lowers the number of defects, raises efficiency and cuts costs. The seven tools should be applied in as many ways as possible. Just as it is absurd to say that QC activities cannot be called such unless all seven QC tools are applied, no problem will arise if a firm uses only the tools that suit its needs.. Excessive standardization should be avoided. As previously stated, the application of methods have great latitude depeuding on what the tools are used for. The same applies to the sequence of their application. There is also a method in which the direction of planning is determined through a subjective and rough positioning. For example, the "in the beginning there was an idea" principle applies to the seeds idea development method described below.

The author and his colleagues' proposal for P7 can be compared to a restaurant, where a recommended full-course dinner is available while at the same time various dishes are offered à-la-carte. The author and his colleagues sincerely hope that their intention will not be misunderstood.

3. Present and future of P7

3.1 Publication

The author is in the midst of writing a text tentatively titled "Seven Tools for Product Planning - Tools for Developing New Products," The work is slated for publishing by JUSE in late October. Co-authored with the four researchers listed earlier, it was originally intended as a text for use at seminar mentioned below, but the author decided to publish it for general readership in order to meet many and diverse needs. He solicits frank comments on the book.

3.2 Seminar

The Seminar on the Seven Tools for Product Planning is scheduled to take place at JUSE's Higashi Koenji building in Tokyo on November 21 and 22, and December 21 and 22. Its program consists of:

- November 21
  - Introduction
  - Group interviews
  - Surveys using questionnaires
- November 22
  - Positioning analysis
- December 21
  - Idea development methods
  - Conjoint analysis
- December 22
  - Quality charts

Case studies

The program was designed so that those in attendance can master the seven tools in four days. Participants will practice most of the tools and instruction will enable them to learn how to apply the tools by themselves. Personal computers will be used particularly for learning the quantitative methods of positioning analysis and conjoint analysis. No complicated computing is necessary. Preliminary knowledge of SQC methods is welcome but is not required. The seminar is therefore suitable for a wide variety of planners from departments ranging from planning and research to R&D and design. It also welcomes persons who majored in liberal arts during college. The seminar will offer solutions for planners who cannot read the intention of consumers, develop good ideas, plan new products making the most of accumulated technologies, or decide how to balance between price and quality.

If possible, the author wishes to develop many case examples together with seminar participants from companies, and make the methods more effective and solid. The cooperation of participants will be deeply appreciated.

For a detailed schedule, direct inquiries to Business Division I at JUSE.

3.3 Software

In addition to seminars and texts. the author and his colleagues place importance on personal computer software. Today, even if a P7 tool is convenient, it is unworkable without the availability of easy-to-use software. Considering that planning itself presents a battle with time and that not all planners are good at certain methods, it becomes highly important to establish a system that anyone can use easily and conveniently.

This, however, represents an enormous issue and remains as a matter for resolve as the author writes this article. He wishes to discuss it in more detail on another occasion.

3.4 Japanese Society for Quality Control's "Product Planning Study Meeting"

TRG had conducted research on P7. In order to make it more open and promote research on a wider scale, the author applied to the Japanese Society for Quality Control for establishment of a "Product Planning Study Meeting," and the application was accepted (he now serves as manager of the meeting). While making P7 its central research theme, the study meeting intends to discuss various product planning methods, techniques, and case examples without sticking to P7. Currently, the meeting has as many members as its needs, but guest speakers who can present case examples related to product planning (not limited to P7) are most welcome. Those who wish to speak at the meeting are requested to contact the author (address and phone number listed at the end of this article).

3.5 Seeds idea development method

The "seeds idea development method" is an original means that the author recently developed in his study on the basis of hints received from his lecture meetings. This method is most suitable for companies that wish to apply their original technologies to products other than existing ones, or those which have acquired new unexpected technologies and wish to know how to make the best of them. At first. the majority of idea development methods came from marketing research in America, thus few are technology oriented. Traditionally, many Japanese product planners have been those who majored in science and technology. This discrepancy may pose one of the problems for product planning in Japan.

Our seeds idea development method was first announced at a recent research presentation meeting and fortunately was well received. The author recommends it because, in principle, the method is not so difficult and systematically provides a large number of ideas in a short period of time. Ideas thus obtained are examined by measuring customer needs through group interviews and polls using questionnaires, and as a result. planners can gain good prospects for product planning. This differs from the recommended order of using the tools, but there is no problem whatever. The method is also highly effective when planners wish to make the most of their firm's original technology after the direction of planning is determined based on surveys. Grounded on idea development check lists and the analogy method of tabular-format idea development, this seeds idea development method works to combine with other technologies or replace them with something original. It enables planners to obtain more than ten times as many better (or original) ideas than when they think vaguely. More detailed explanations are available in (4) and (6) listed in the bibliography. Readers who wish to obtain copies of these books promptly are asked to contact the address given at the end of this article. Their copies, plus additional information, will be mailed.

4. Conclusion

Few of the P7 tools the author and his colleagues propose are novel. Actually, the author has received criticism from such a viewpoint. Originally, however, these tools were developed because they are either:

- Easy to use,
- Effective,
- Already well established, or
- One the author hopes to see widely used in the future.

And the author firmly believes that they will be powerful as a whole. What is required today is not "novel methods" but " effective methods." It should never become a subject that academics research for the sake of research. One reason that, strangely, no comprehensive proposal like P7 has existed in Japan's marketing circles seems to be that many of the marketing researchers fail to recognize any problem even if product planning methods are not put together, because companies conducting product planning properly are doing very well. The author is afraid, however, that such a easygoing way of thinking may not be able to prevent the appeal of Japanese companies' products from declining in world markets.

The author hopes that further advice and support will be given to his and his colleagues' research activities.

The author's contact:
Seijo Univ rsity Faculty of Economics
6-1-20 Seijo
Setagaya-ku, Tokyo 157
Phone: (03) 3482-1181
Facsimile: (03) 3482-3560

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(10)

TQC for Accounting

by Takashi Kanatsu

CONTENTS

Accounting TQC and Management Planning

Management Planning and Accounting. In the realm of management, accounting operations play a more powerful role than is immediately obvious. In the normal course of events, accounting professionals interface with other departments of the company in critical situations demanding leadership and negotiation skills. Doing more than creating the company's business plan, the accounting department performs calculations concerned with profits and losses and the capital needed for sales plans and production plans. These calculations are the basis for adjusting sales, production, or long-term equipment plans as well as for developing capital plans. From this, we can conclude that the accounting function is broader than regulating money.

Manufacturing has enjoyed superior status in Japanese society since the Tokugawa period (1603-1867) and the association of the abacus with commerce. This relationship persisted throughout the militarization of Japan's economy from the Meiji restoration in 1868 through World War II, continuing into the postwar period, when production remained top priority. The commercial foundation of Japan reflects the superior social position of the samurai warrior over the artisan. In postwar Japan, as companies recovered their capitalization, their financial positions improved and accounting changed. No longer the domain of merchants, accounting assumed a central position in business management by its identification with the new business "samurai" class.

Accounting's central role in the postwar years later gave way to a supporting role. However, the financial manipulations required by the yen's appreciation have reversed that trend. While this book does not examine these issues, I bring them up to illustrate the importance of accounting.

Today, accounting occupies a primary position in business operations and management planning. This makes accounting important in the deployment of TQC and the development of business plans. The view that restricts accounting TQC to"office work QC" is neither true business management nor true TQC.

Since business plans begin with sales plans, we will discuss how to develop sales plans with an accounting perspective.

Understanding Your Company's Position in the Marketplace. The starting point for both sales and business plans is obtaining accurate data about your company and the marketplace. We all know this. Let's consider the function of TQC in accounting for this stage.

Understanding your company's state. In practical terms, a company's economic survival depends on sales. It follows that sales are the source of the profits and losses that ultimately express the state of a business. Thus, any meaningful business plan must address sales. While other accounting books exhaust the discussion of profits and losses, we will examine matters relating to sales, a topic generally not addressed directly.

An accounting department obtains its sales information from budgets and financial analyses, while a sales department views the situation from a different perspective. At some point, the approaches of both should coincide in order to achieve the goal of increased sales. A sales department employs certain themes as it promotes TQC during the development of a sales plan. The accounting department, as the foundation for marketing, must be aware of the other's perspective. The following are points both accounting and sales departments must understand and agree on:

1. Decisions should not be based on changes in the gross sal[illegible] figures. Instead, sales should be classified by

product and sales trends. Based on these trends, estimates of a product's lifetime can be made and seasonal sales variations previously undetected can be found.

2. Decisions should be made for different product classifications (i.e., machinery) to determine whether new or secondary products (i.e., accessories and related consumer products) should be added to the primary product line. Sometimes, to simplify calculating costs and the delivery of finished products, these new or secondary products are not considered separately. Failure to do so, however, makes it difficult to position a company in the marketplace. For example, if sales efforts focus only on primary products, business activities may be inefficient. Logically, sales trends in new or secondary products improve our ability to anticipate trends in the primary product.
3. When considering sales in terms of individual products, we should be interested in how retailers display the product and their sales trends for each shelf. We should compare our products to those of different manufacturers displayed on the same shelves (i.e., in terms of packaging and price range). Display management is important and will be discussed with the ABC's of product structure analysis in the Pareto chart section of Part IV.
4. Don't just examine aggregate sales or the total units sold at the end of the sales period. Analyze market share and inventory as well. This means knowing how to handle data and make graphs.
5. When examining the sales of a company that produces to order, do the following:
   - Classify the work orders by product (i.e., electrical, automotive, machine tool).
   - Check product shape and weight, and whether the design is amended.
   - Look at the production time — estimated and real. This information is needed to prevent defects during mass production and sales. Note the exact number of adjustments made (1) between order and delivery and

(2) after delivery. Any problems (e.g., with ordering conditions, estimates, process control) should be addressed at this stage.

Use this information to revise your view of the market trends and the technological and sales characteristics of your company. Clarify the future direction of the business — whether it is expected to expand or contract — and the reforms that should be made.

Understanding the marketplace. Determining the true state of the marketplace and your company's position in it is an important step in setting sales plans and business goals.

Small and mid-size companies that lack a staff specialized in market surveys, however, often make sales plans using estimated target values and achievements decided at the whim of the sales department. Sometimes plans and target values are decided on the basis of the knowledge and experience of the company's top management.

There are drawbacks to these methods. Judgments made by the sales department alone tend to be short-sighted and defensive in their treatment of survey results and sales planning. Plans made unilaterally by top management tend to be overly optimistic or to rely too much on achieving the goal by working harder.

This is where the accounting department comes in. Accounting is in a position to understand management's goals as well as obtain objective data. It can fill a real need within the company, taking an active planning role by cooperating with both the sales department and top management. Let's examine some points regarding surveys:

1. The accounting department can obtain valuable information through its contacts with financial institutions, economic organizations, and government agencies, as well as with certified public accountants and tax specialists. It should obtain data from its own and other regions and industries in order to make comparisons to its own company.
2. Economic reports published periodically by regional governments and financial institutions often contain graphs with information that your company can use to determine market trends.
3. Interpreting and evaluating economic and financial data is probably the most conventional role for an accounting

department. Utilize this position by having the department regularly make and distribute graphs and tables based on company data.

4. A word about "official" statistics: Many official statisticians use graphs to show price trends and the state of the economy compared to the same month last year. Companies should be cautious about using this method.

Graphs that compare activity in a given month with the same month of the previous year are useful if the environment reflects only seasonal variations. If this is the case, these graphs can help companies to infer steady trends in business or sales. If the environment has been changing, however, these graphs may yield deceptive data. The following example illustrates why:

A retail store had been expanding steadily until a competing supermarket appeared. The result was a decline in sales that forced the store to concentrate on maintaining profitability rather than on recovering its sales position. However, the sales curve of the past year showed no apparent decline. While management found this reassuring, a long-term view revealed falling sales and a rapid deterioration of the store's position in its region. When the economy or environment is changing, a simple time-series graph is more appropriate. In this case, a clear picture of sales trends was obtained by using a three-year Z chart (see Part IV).

Official statistics, of course, often are not broken down sufficiently and sometimes are late. Always examine such statistics in the light of your own standards to determine their usefulness to you. Official statistics may have as much to do with your company as National Weather Service forecasts have to do with predicting the weather from the glow of the sunset on a mountain peak.

Setting Management Objectives. Management goals have two basic components: the quantitative position (or share) and the qualitative position (quality, price, or brand recognition) of the company in the market. These positions describe the company — its symbolic goals and the profit goal required to make the company a going concern. While the two are closely intertwined, accounting usually stresses the second goal of profitability. In today's economy, however, the first goal of distinguishing a company from its competition is actually more fundamental and far-reaching.

This continuous process is called "policy management" in TQC. The methods used for setting goals should clarify the following:

- Which product
- Which price range or class (i.e., large, medium, small or deluxe, regular, economy)
- Which market (i.e., national, regional, in a certain industry) and how large a market share you need to have the number one position; how long it will take to attain your objective in quantitative terms. Based on these figures, set specific mid-term, long-range, or yearly objectives for each product, for each region, and for each period. Use them also to devise specific yearly policy plans for each department.

To reiterate, a small or mid-size company will express its sales objective and profit objective relative to the previous year. The accounting department plays a role in adjusting and coordinating plans such as sales or management plans to meet these objectives. This can be called Management by Objective (MBO), in which a plan follows straight from objectives or an accounting-led method. The TQC planning process has to begin with objectives based on data that reflects the situation realistically. Being the providers of this accurate data places the accounting department in a leadership role and, therefore, in a position to foster TQC in management planning during the planning stage.

Even small and mid-size companies that cannot spare the personnel to carry out elaborate data collection and establish policies can introduce TQC, make sure top management understands the TQC philosophy, and then gradually put it into practice, beginning with devising a plan. The improvement methods will be made clearer by addressing questions of organization, procedure, and personnel. In sum, "haste makes waste."

Personnel issues should be handled by responsible people in the accounting department. Management plans should be developed in accord with clear company polices to train people to serve the company in the future. In some instances, small companies will benefit from the assistance of an outside consultant or a tax accountant. Even in these cases, however, it is vital for management to understand and make decisions based on the TQC approach to management planning.

Although planning is more the responsibility of a first-class businessperson than the accounting department, the latter plays an essential staff support role in this process. This is the meaning of accounting TQC.

The Operating Budget. Management planning requires developing yearly operating plans based on the mid- and long-term goals of the business. These business plans are quantified in dollars in a budget, according to which activities of the operating plan are deployed. Therefore, controlling the budget is a computational system to manage all company activities and achieve the operating plan.

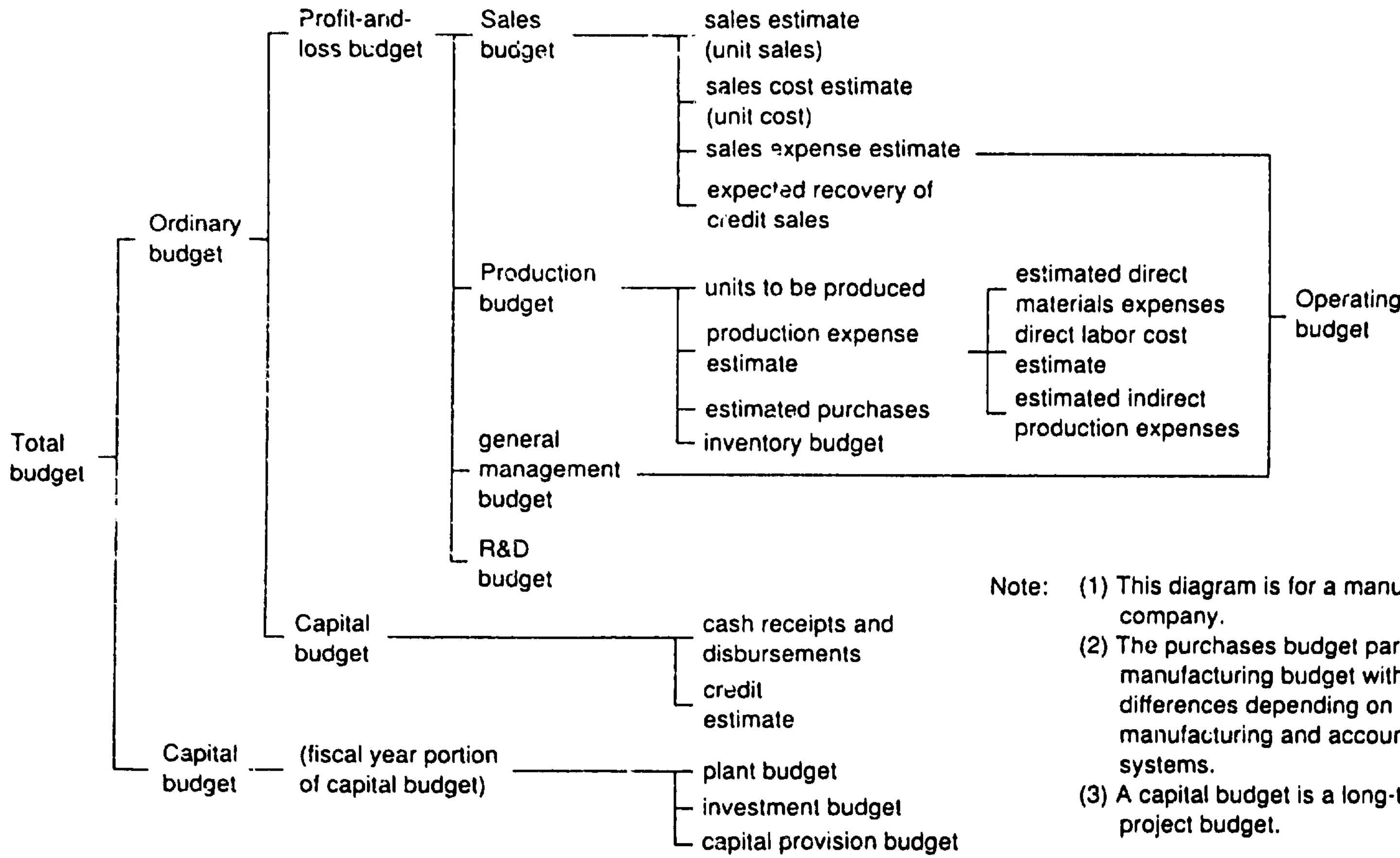
I am concerned chiefly with the profit-and-loss part of this system. A general outline of the budget system is illustrated in Figure 3.1.

Recently financial manipulations have become important in accounting departments and their operations. This might appear to differ qualitatively from management planning, especially budgeting. As a practical matter, however, this type of financial manipulation is not a serious problem for accountants. Since such financial manipulations are not related to TQC, they will not be addressed here.

Personnel expenses in the sales department. The foundation of all sales activities is people. People have built the distribution system and expanded the organization, particularly with the gradual increase of communication in sales. Budget costs related to people are called personnel expenses. These are not the same as the labor costs that include the cost of operating manufacturing equipment and maintaining office personnel. Sales personnel have great strategic importance, because if their activities are not carried out, company operations cannot be performed. A sales department's personnel costs are not simply labor costs; they can be evaluated only in relation to a company's annual sales and profit figures.

Nothing is more important than this type of personnel cost. Although sales personnel costs are placed under the category of sales expenses, they actually should be calculated and evaluated separately.

Overall personnel costs should be discussed in a budget. These personnel costs should be broken down into individual salaries, bonuses, allowances, awards, and so forth. We should pay attention to the method for analyzing these expenses. Here are some guidelines:



Note: (1) This diagram is for a manufacturing company.
(2) The purchases budget parallels the manufacturing budget with differences depending on the manufacturing and accounting systems.
(3) A capital budget is a long-term project budget.

Figure 3.1 The Budget System

- For determining market conditions, nothing is more important than visiting customers. This increases sales and is worth doing even though increasing the number of sales calls decreases the orders/sales ratio. In other words, efficiency declines.
- Trends in products and competitive marketing strategies become apparent when your competition is more successful. Therefore, understanding these trends is important. A philosophy is needed that aims at becoming more competitive even if you have lost the first few rounds.
- Acquiring new customers is the most significant way to expand the market and increase market share. The number of new users is more important than the dollar value of the orders received.

The qualifications of your sales staff are more closely related to experience than is the case for other professions. Individual experience and human relationships play an important role in operations and cannot be described fully in operations manuals. This situation differs from that for a company's manufacturing personnel and means that marketing performance cannot be evaluated by sales alone — the value of experience must be considered in the personnel budget beforehand.

The Japanese tradition of seniority is very strong. In fact, many companies have a compensation system that parallels the seniority pay and is calculated directly on the basis of sales. I believe that insofar as the accounting personnel, with their skills in calculation, understand the theory of executive compensation, the marketing personnel will have strong incentives for achievement.

Training expenses. Another important topic related to personnel is training and training expenses. Although all textbooks stress the importance of training, the time and expense it calls for are often cut during the budget-making process. This is because the personal benefits of training have been stressed and training relevant to company operations, such as using manuals to teach operating techniques, has been neglected. Therefore, the accounting department should be an advocate for the personnel and training departments during the budget-making process.

Choosing a method is one of the important characteristics of TQC. TQC places a high value on all aspects of training, including teaching the TQC method. Therefore, training expenses have a central place in the accounting TQC → business plan → budget process. Understanding TQC's philosophy and method of implementation, rather than its form, is most important for improving accounting.

In Part III, we will discuss training in the accounting department.

Research and development expenses. Selling new products is the most important strategy for producing continuous growth in a going concern. The importance these days of improved research and development of new products goes without saying. Recently, a business newspaper reported that even companies not seriously affected by the economic changes brought about by yen appreciation have greatly increased their R&D spending.

TQC has evolved from a narrowly focused rationalization movement and a QC circle movement striving to reduce costs to a QC-based approach to research and development. These changes have promoted TQC in accounting and made R&D expenses a natural domain of accounting.

Plans are made and budgets are controlled by project in R&D expenses. Cost-effectiveness analysis and other methods that measure results and efficiency thus play an important role in making budgets.

R&D expenses and budget-making considerations. Research and development costs are all costs related to current production and other kinds of research and development. These costs are divided into basic research, applied research, and new product R&D. Accounting has a role to play in analyzing experiments as well as research and development work relevant to accounting. This holds true not just for tax law but for maintaining the advancement of R&D program development.

Three aspects of R&D that should interest the accounting department are:

1. The course of R&D guided by the long-term business plan.
2. The systematic arrangement of R&D using characteristic diagrams and other methods.
3. The issue of whether the marketing department should help draft the R&D budget.

Mapping R&D costs. Guidelines for making financial tables for research and development expenses call for separate entries for "general management costs" and "marketing costs and general marketing costs." Two reasons for this separation are tax law and the continued growth of the company.

Categories for these financial tables include personnel costs, materials costs, the depreciation cost of real fixed property, and other expenses. These are not just accounting categories. They have real bearing for each research team on the relationship between research progress tables and the budget.

Other important points in R&D costs. Some people protest that research and development is risky or that it should be allowed to proceed step-by-step. In a very competitive environment, the question of what R&D can and cannot accomplish figures prominently in a product's success. Moreover, although many R&D issues will touch the accounting department, accounting should not attempt to manage the details of a research program. These details should be handled by the self-management method that will be explained later. What should concern the accounting department is the overall system and the characteristics charts based on the company's long-term strategy. TQC's management guidelines must be stressed at all times.

The main points of the budget must be understood thoroughly; at the same time, its contents should be applied flexibly. Decide beforehand how to take advantage of this flexibility. Think of the R&D budget as you would the price controls in the manufacturing department's budget.

The QC approach as applied to research and development goes beyond the seven QC tools. It extends to the seven "new" QC tools and methods, such as experimental planning. These additional methods are not part of the accounting department's regular operations, as are the seven QC tools. The seven "new" QC tools include the arrow diagram, matrix, and experiment planning methods. They are described further in Part IV. Everyone in the accounting department should be acquainted with them.

It is important to decide early in the budget-making process how you will measure whether R&D funds are being spent effectively. Refer to specialized books for evaluation methods. Remember that evaluating the gradual progress of research activities and business operations are two different things.

Although R&D spending is aimed at new product development, some spending should always be budgeted for opening up new markets, making surveys, determining which market and which new product to introduce. Like research and development, these efforts should be ongoing and systematically planned and budgeted.

Inventory budget. The manufacturing department sees inventory control as a problem of materials and work-in-process, while the sales department sees it as a problem of inventory. Changes in fashion cause many inventory problems. We can understand inventory best by examining the problem of beginning inventory and how to budget it. The basic formula for beginning inventory budgets is:

$$\text{Beginning inventory budget (excludes all other costs for laying in stock)} \left\{ \begin{array}{l} = \text{expected sales price (sales price only)} \\ + \text{inventory at the end of the plan period (assuming no decrease in stock)} \\ - \text{inventory at the beginning of the plan} \end{array} \right.$$

Many other factors can be added to this basic formula to make formulas such as the economy order quantity (EOQ) and the optimal inventory level. While we have no need to discuss these formulas here, I am providing them as a reference.

Reference 1: A formula for calculating Open to Buy (OTB) from the EOQ.

$$\text{1. Economy order quantity (EOQ)} = \sqrt{\frac{2 \times \text{total expected annual sales} \times \text{order costs per order}}{\text{inventory cost per product} \times \text{ratio of inventory maintenance cost to total value of inventory (the inventory maintenance cost ratio)}}}$$

$$\text{2. Order period} = \frac{\text{economic order quantity (EOQ)}}{\text{weekly sales objective}}$$

3. Maximum quantity of goods on hand = (order period + delivery period) × weekly sales objective + R (inventory cushion based on the Poisson distribution which guarantees with 99% probability that a product in inventory

Where, $R = 2.326\sqrt{(\text{order period} + \text{delivery period}) \times \text{weekly sales objective}}$

4. Open to buy (OTB) = (maximum amount in hand) − (estimated amount remaining after shipment)

Reference 2: Three formulas for determining the optimal inventory level at the beginning of the month.

1. Standard inventory method

Optimal inventory level at the beginning of the month (retail prices) = anticipated sales for the current month + standard inventory

$$= \text{current month's sales} + \frac{\text{expected annual sales}}{\text{expected annual product turnover rate}} - \frac{\text{expected annual sales}}{12}$$

= (average annual inventory level (retail price) − monthly average expected sale + expected sales for the current month

2. Percentage variation method

$$\text{Optimal inventory level at the beginning of the month (retail prices)} = \frac{\text{expected annual sales}}{\text{expected annual product turnover rate}} \times \frac{1}{2}\left[1 + \frac{\text{expected sales for the current month}}{\text{expected monthly average sales}}\right]$$

$$= \text{average inventory} \times \frac{1}{2}\left[1 + \frac{\text{expected sales for the current month}}{\text{expected monthly average sales}}\right]$$

3. Inventory sales ratio method

Optimal inventory level at the beginning of the month (retail sales)	=	expected sales for the current month × inventory sales ratio

Note: Previous inventory sales ratios are calculated using:

$$\frac{\text{Inventory at the beginning of January (retail price)}}{\text{January sales}} = \gamma_1$$

$$\frac{\text{Inventory at the beginning of February (retail price)}}{\text{February sales}} = \gamma_2$$

Calculating these ratios for each month is convenient for making adjustments for seasonal variations.

I present these formulas, which can be used to calculate many different factors, to point out that they are based on statistical methods and a certain approach. These formulas and QC methods should be implemented in tandem.

Therefore, the standard values for allowable error in beginning inventory and for inventory calculated using these formulas are used in daily inventory control operations guided by the QC approach. TQC makes the accounting department responsible for developing a budget and taking the lead in its implementation.

(Of the many Japanese textbooks on inventory control, Hideo Yoshikawa's *Practical Inventory Control* is a fine explanation of TQC based on a discussion of supplying replacement parts for industrial products.)

Plant Budget. The plant budget is part of the capital budget rather than the current budget since it affects company strategy over the long term. The plant budget is very important to the comprehensive, companywide nature of TQC.

In recent years, leases have been used for their convenience from the standpoint of capital and as a response to rapid changes in business conditions. The plant budget should not be seen exclusively as a long-term budget; short-term processes also have their place.

The following are some basic issues in plant budgets:

Calculating the economics of plant investment. Before beginning our discussion of plant budgets, we should present several types of formulas for calculating the economics of plant investments. Just as there are many statistical factors involved in the calculation methods for determining the optimal inventory level introduced in the previous section, there are also several calculation methods for determining the economics of plant investment. Accounting departments have combined the approaches, in particular the statistical techniques of QC, with conventional methods for calculating the economics of plant investment in order to better understand these calculations.

It is easier to understand numerical values such as cash flow and the residual value of plant and assets, which are basic materials used in the discounted cash flow (DCF) method calculations, by using graphs rather than tables and formulas. These graphs make the accounting department's calculations of company objectives and its plans for achieving those objectives easily understood by people throughout the company. This is excellent TQC.

Profit comparison method.

1. Pure investment profit method

Total investment profit = (total cash flow + residual cost)
− total amount invested

(*unit = dollars)

2. Net current value method

$$Y_1 = -\sum_{t=0}^{T} \frac{I_t}{(1+K)^t} + \sum_{t=1}^{T} \frac{R_t}{(1+K)^t} + \frac{S_T}{(1+K)^T}$$

Where, Y_1 = net current value; I = annual investment value (sum of plant investment and liquid asset investment); R = annual cash flow (sum of business profit and depreciation); S = residual value (sum of plant residual value and residual value of liquid assets); T = plant life; t = each year of plant life; K = capital cost ratio; and $I/(1+K)$ is the discount of I on the basis of K in order to convert to current prices.

Cost comparison method.

1. Simple investment cost method

Total investment cost = total plan operating expense − total plant investment
(*unit = dollars)

2. Capital recovery factor method

$$Y_2 = \left(-\sum_{t=0}^{T} \frac{F_t}{(1+K)^t} + \sum_{t=1}^{T} \frac{C_t}{(1+K)^t}\right) \times r, \qquad r = \frac{K(1+K)^T}{(1+K)^T - 1}$$

Where, Y_2 = annual cost recovery; C = annual plant operating cost (after depreciation, before payment of dividends); F = plant investment in each year; and r = capital recovery factor.

Investment profit ratio.

1. Pure investment profit ratio

$$\text{Investment profit ratio} = \frac{\text{average annual cash flow}}{\text{total value}} \times 100$$

(*unit: %)

2. Discounted cash flow (DCF) method is best for calculating return on investment (ROI)

$$-\sum_{t=0}^{T} \frac{I_t}{(1+x)^t} + \sum_{t=1}^{T} \frac{R_t}{(1+x)^t} + \frac{S_T}{(1+x)^T} = 0$$

Where, x = discounted investment profit ratio; T = plant life; t = each year of plant life; I = amount of investment for each year = plant investment + increase in operating capital; R = cash flow for each year; and S_T = residual cost = book value of plant and assets + operating cost residual

Profit indicator method.

1. Pure profit index method

$$\text{Profit index} = \frac{\text{total cash flow}}{\text{total plant investment}} \qquad (\text{*unit} = \text{index})$$

2. Discounted profit index method

$$Y_3 = \frac{\sum_{t=1}^{T} \frac{R_t}{(1+K)^t}}{\sum_{t=0}^{T} \frac{I_t}{(1+K)^t}}$$

Where, Y_3 = discounted profit index.

Capital recovery period method.

1. Simple capital recovery period method

$$\text{Number of years to recover capital} = \frac{\text{total plant investment}}{\text{annual cash flow}} \qquad (\text{*units} = \text{years})$$

2. Discounted capital recovery period method

$$-\sum_{t=0}^{T} \frac{F_t}{(1+K)^t} + \sum_{t=1}^{N} \frac{R_t}{(1+K)^t} = 0$$

However, N = number of years to recover discounted capital.

Guidelines for preparing a plant budget. The accounting department should keep the market as well as manufacturing factors in mind as it develops a plant budget.

The purpose of plant investment is to increase productive capacity by updating and improving the plant and its equipment, including improvements in product quality and performance.

Meanwhile, the accounting department is charged with adjusting the company's marketing system to increase market share and profits that will keep pace with increases in production.

Production lines. For example, changing production from a cutting process to a press process is a simple way to increase production. If an increasing variety of products is produced in small lots, the people involved will need a strong grasp of market conditions to decide whether (1) to produce products in small lot quantities using press processing, or (2) to reduce the number of varieties and increase lot size. This will enable them to cut into the market share of other companies' products by taking advantage of cost and marketing advantages. Moreover, some companies that convert from cutting processes to press processes do not respond to production increases or decreases with corresponding increases or reductions in the work force or operating hours. They choose to allow for variations in the plant utilization ratio rather than destabilize their work force. The accounting department's task is to discuss whether these issues have been handled properly.

For the sake of rationality, plants generally are organized around their production assembly lines. In the light of the increasing diversification of products and materials, however, the production line system should be reconsidered. In some cases, the question of whether a production line is the best method should be raised — for example, when switching from steel to fiber reinforced plastic (FRP) or, if steel is kept, switching to the production of other products.

Leasing. Plant leasing has become common recently. Leasing is easy to handle from an accounting standpoint, and borrowing things is convenient. However, the relationship between the leasing period and the period of effectiveness of the plant should be considered carefully.

Plants and machinery often are leased for four or five years. Conveyors will not become obsolete in that period unless there is some unforeseen change in conditions. Processing equipment, however, should not be leased for more than two years because of rapid developments in efficiency, materials, and production technology. Even if a provision for changes after two years is written into a four-year contract (that is, if the current conditions expire after two years and a new contract is signed), costly modification fees are charged. One-year leases are very expensive. Clearly, the plant budget should reflect the relationship between the leased plant and the terms of the lease.

TQC and the accounting department thus play important roles in the budget-making process. It is also necessary to monitor certain trends:

- Keep a close watch on the diversification of the economy. Collect information and data from any sources that may be relevant to marketing.
- Be aware of changes in individual product sales and watch for changing trends in product life and materials used by your company. Compare these trends with those of other manufacturers and the market. Graph long-term (ten-year) trends in society and the economy. This is an important responsibility of the accounting department.
- Periodically track trends in the distribution of producer goods, such as equipment and plants.

More plant budget formulas. In addition to those most commonly used, the accounting department should consider other formulas to calculate plant investment on a case-by-case basis. These formulas will not be discussed here because explanations can be found in other books on accounting.

The MAPI formula is a plant replacement formula developed in 1949 by George Terborgh, research director at the Machinery and Allied Products Institute (MAPI) in the United States. This formula is based on the concept that plants should be selected by comparing the future costs of new and old plants. Mr. Terborgh also proposed a chart for determining the average cost of a plant based on its predicted lifetime. This easy calculation method is very popular.

The location of a retail outlet is as important as the investment made. The well-known Reilly and Nelson rules are used in making this decision. The accounting department should be aware of these simple formulas.

The W. J. Reilly rule. The Reilly rule for calculating the market area says: If there are two large cities A and B, there is a point that divides their respective purchasing power boundaries. The position of this dividing point is proportional to the population of the two cities and inversely proportional to the square of the distance between them. The Reilly formula is expressed mathematically as follows:

$$D_a = \frac{D_a + D_b}{1 + \sqrt{\frac{P_b}{P_a}}}$$

Where, D_a = the distance between city A and the dividing point; D_b = the distance between city B and the dividing point; P_a = the population of city A; and P_b = the population of city B.

Japan's Ministry of International Trade and Industry (MITI) uses this rule when making decisions about location changes of big stores. The modified Huff model shown next corrects a shortcoming of the model proposed by D. L. Huff.

$$P_{ija} = \frac{\frac{S_{ja}}{(T_{ija})^2}}{\sum_{j=1}^{n} \frac{S_j}{(T_{ij})^2}}$$

Where, P_{ija} = for the most popular product, the relationship between the commercial district *ja* in the survey area *j* and the sales rate; S_{ja} = the sales floor space for the most popular product in commercial district *ja*; T_{ija} = the distance between the survey area and the commercial concentration *ja*; S_j = the sales floor space for the most popular product in commercial concentration *j*; and T_{ij} = the distance between the survey district *j* and commercial district *ja*.

The Nelson rule. The Nelson rule is called the theory of cumulative attraction in retail management and the coexistence rule of retail management. This rule states that there is a definite relationship between the sales figures of two stores but it does not say that both stores will fail.

$$V = I(V_L + V_S) \times \frac{V_S}{V_L} \times \left(\frac{P_L}{V_L} + \frac{P_S}{V_S}\right)$$

Where, V = total increase in sales of the two stores; I = the extent to which the two stores exchange customers; V_L = sales of the larger store; V_S = sales of the smaller store; P_L = sales of purposeful purchases from the larger store; and P_S = sales of purposeful purchases from the smaller store.

The plant equipment investment in a store is directly related to the company's success or failure. This investment merits more attention than the purchase of ordinary machinery. According to Furuda Okanobuo's book *The Lanchester Strategy*, Japan's cities were attacked from the West. This theory applies to small stores as well as to automobile dealerships and sales centers for large machinery. Calculating where to place a retail outlet takes into account more than low rent and the alignment of roads. I have presented several representative calculation methods to show the role of TQC in accounting department operations.

Zero-Based Budgeting. Zero-based budgeting became famous when President Jimmy Carter introduced it into the budget- making process of the U.S. government. I want to discuss this American innovation from a QC perspective.

Texas Instruments developed zero-based budgeting in 1970 as a system for separating the budgeting of tasks undertaken by departments indirectly involved in a project. I won't explain zero-based budgeting here because it is covered in such Japanese books as *Zero-Based Budgeting*, by Osamu Nishizawa. Suffice it to say that in zero-based budgeting, the budget process does not begin with the current budget. Rather, the initial process goes all the way back to the first step, or zero point, of the budget-planning process.

- The first step in zero-based budgeting is to analyze past achievements and assign priorities to objectives and tasks.
- Zero-based budgeting requires that the sequence objective, planning, executic 1, and evaluation of each task be easily understood. This prevents operations and management from getting bogged down in routine.
- Zero-based budgeting makes it easier to measure and analyze costs and benefits.

Zero-based budgeting follows the same steps that TQC follows in management. It is a budget system in which accounting's primary responsibility is to observe the market and operations from a new perspective.

"Cut costs by 20 percent" has become a popular slogan in Japan in response to the diversification of the economy and yen appreciation. The hazard of this is that spending for important projects and research and development may be cut, while a lot of waste is left untouched. Applying accounting TQC is an excellent way to prevent this kind of cost cutting — and even a partial zero-based budgeting system is worth implementing alongside the accounting TQC process.

In the zero-based budget system, the budget-making process begins with each department manager creating a decision package for each operation. It focuses on the work and responsibilities of departments and sections, asking top management to accept decisions made by subordinates. In Japanese organizations, managerial operations and responsibilities often are poorly defined and zero-based budgeting implemented superficially. Thus, zero-based budgeting is not a true management system in Japan. Nevertheless, we can use the system effectively in conjunction with the deployment of TQC to pull companies out of the mire of routine and make management more innovative.

Implementing a Budget and Accounting TQC

Executing a Business Plan and Accounting TQC. From accounting's perspective, executing a management plan or operating a business means implementing a budget. This is the cornerstone of business management. The role of accounting at this stage can be divided into two parts:

- to advise and support each department in implementing its portion of the budget
- to implement its own accounting department budget

This means that from a QC viewpoint, accounting's first role is total (companywide), while its second role is applying QC methods to its own accounting operations. This latter role will be discussed in Part III. In this chapter, we will consider accounting operations from a TQC perspective.

Accounting's first role concerns all phases of business operations, a subject too large to address here. To avoid being superficial and overly abstract, we will confine ourselves to three topics:

1. how the accounting department supports the budget implementation of other departments and how these departments can apply QC methods to budget operations
2. changing the budget mid-term to accommodate changes in the business environment

3. improving the effectiveness of the budget implementation process

Applying QC Methods to the Budget Implementation Process. Departments are individually responsible for properly implementing their portions of the total company budget. However, even if all budget objectives are achieved, the content and sequence of procedures used to implement them may be inefficient. These inefficient procedures underutilize a company's potential and prevent individual departments and related offices from achieving their objectives. While fulfilling their responsibilities under the plan, departments should use all available specialized information to help each other overcome problems unforeseen in the plan. Regardless of department, the goal of everyone must be to successfully meet the company's overall budget objectives. This explains the "T" in TQC — it stands for total.

We could describe the accounting department's role as that of the heart through which budgeted funds flow and give life to the entire company. Capital should not be allowed to circulate outside the budgetary framework. The following examples will illustrate this point.

The marketing department is responsible for orders, inventory, and sales. In Part I, we stressed that all operations flow from the sales plan. Although many companies that produce manufacturing parts start from a production plan, from a marketing standpoint, everything begins at the sales plan. These sales plans include production and the taking of orders. However, a serious problem arises when production management considers manufacturing and raw materials in the same breath. We will look at why in the following pages.

The relationships among sales, inventory, and raw materials are crucial. An important accounting department task is to use graphs to describe these relationships and maintain a balance between them. Although people frequently find graphs difficult to read, the graph applications presented here demonstrate their accessibility.

To distinguish between different materials and processing stages, the marketing department uses graphs to break down information by product and by production department. The accounting department uses graphs to chart relationships between operations in different areas, a process made easier by the current proliferation of computerized software.

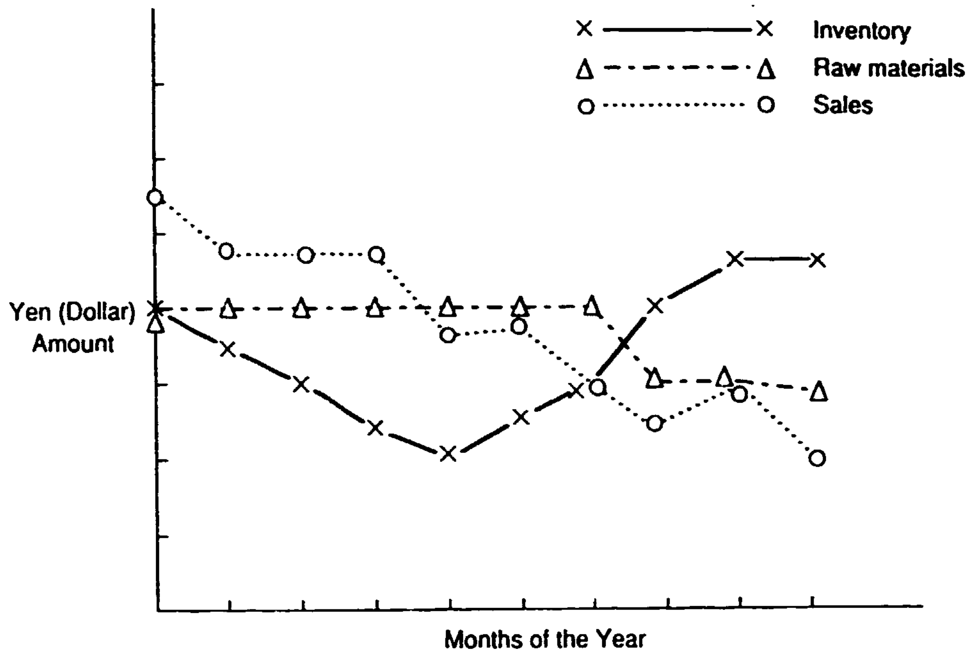


Figure 4.1 A Graph of Inventory, Raw Materials, and Sales

To look only at production management in the production department, we would have to consider the processes of laying in stocks of raw materials, material inventory, start-up, and product inventory. We also would have to consider the long, complicated flow of inventory to retailers by way of the marketing department as well as the corresponding decisions and adjustments to be made by the accounting department. In particular, where it is a long process from production to sales, where different regions are involved, and where instructions come from several different sources, departments tend to operate as separate units because they no longer see their relationship to the big picture. For example, although production costs should affect the quantity to be produced, production volumes are maintained at customary levels. This leads to shortages of spare parts and accessories, which ultimately result in disgruntled customers, a fall in sales, and stockpiles of inventory.

If we look at production quantities, inventory levels, and sales volumes in the broader terms of the flow of capital, and then evaluate how rapidly and effectively the budget has been implemented, we can better grasp the accounting department's role in marketing. It is possible for the accounting department to assume a role of quiet but strong leadership in the company. Applying TQC to accounting allows the department to influence operations throughout the company.

The making of equipment investments is often a long, drawn-out affair, and such investments sometimes require special calculations of economic effect or special financial dispositions. For this reason, budgeting should be a joint effort, involving the department that will be installing the equipment, the department that will be using it, and the accounting department. In cases when the equipment construction work takes a long period of time, any dispositions that must be made for cost fluctuations or for financial reasons are the responsibility of the accounting department. The accounting department must take the lead in supervising the operation and also keep abreast of the plan's progress.

Regarding interim checks on budget implementation status, controls normally call for a comparison of the budget in the final stages of the project with the actual amount spent, which offers a way of restricting expenditures in terms of the amount budgeted. The purpose of the interim check, then, is to keep the department informed on a regular or extraordinary basis on whether the budget is being implemented in a way to effectively meet its goals. This is process control; it can be expressed on control charts as control of deviations. Special attention must be paid in the process to the direction and the timing of budget implementation, and while it may not be necessary to account to the exact penny, it must be realized that the problem is not simply one of the final overall total. For this reason, the accounting department needs to take the lead and work in cooperation with each separate division in designing a graph that can show in understandable form the progress of the department's budgetary implementation and planning (including production, acquisitions, and sales plans). In these cases, the use of computers for progress controls is both appropriate and convenient.

A Changing Business Environment and a Midstream Change in the Budget. Sudden changes in the business environment on which a budget is based (for instance, yen appreciation), or an unforeseen action taken by a competitor (for instance, an artificial fiber manufacturer entering the field of biotechnology by making an agreement with a company in another industry) can radically change both marketplace and market shares. In addition, the likelihood that such circumstances might occur has changed the meaning of budgeting.

In implementing a budget, the accounting department assumes TQC's Do role when it becomes aware that the budget must be changed in midstream. The accounting department's contacts with financial institutions and economic organizations puts it in a better position to collect, study, and interpret information on financial affairs, interest rates, changes in stock prices, industrial trends, and so forth. The marketing department, on the other hand, is limited to one industry or one geographic region.

Once the accounting department realizes this, it must assume the responsibility of analyzing information and communicating it to the departments concerned. A TQC-based statistical approach to analysis and statistical charts will become essential. In this way, TQC's "T" of cooperative organizational relationships and the uniform and companywide application of statistical methods are created. This is a concrete expression of the TQC philosophy and methods.

Some specific applications of the philosophy and methods of TQC are presented in the following examples.

Analyzing data. Data and indicators are plotted on graphs or statistical charts. They usually include

- shipments and sales amounts by company in the market area and neighboring regions
- total sales and the number of projects undertaken by related industries
- changes in indicators for principal products and in household budgets
- commercial interest rate and financial data (i.e., the amount outstanding on loans made by local banks)

The data and indicators referred to above are published regularly by local governments and local financial institutions. The accounting department should not only routinely analyze this information but should also obtain and study any background material that helps explain the data. For example, one might examine how changes in a household's economic status affects its expenditures.

Anticipating rapid change. The accounting department should decide beforehand what action it will take if changes in economic trends or changes shown on graphs or statistical charts exceed a certain level. One method for doing this follows:

1. Determine the boundaries (monthly, cumulative, etc.) and nominal values for changes on the chart.
2. Decide what changes you will make in the nominal values of ratios to other companies, such as indicators based on ratios with other industries and competitive targets.
3. If your company is a supplier to other companies, watch for changes in the market share of those who order from you. Look for information in the newspaper. Record these changes on a chart.
4. Decide what kind of report you will make if data exceeds the boundaries and nominal values. Outline the report in advance.
5. Determine what changes you will make in the budget, depending on the nature and magnitude of the change in circumstances. Work out a response beforehand so that you will not be confused or unprepared to meet sudden changes.

If these changes occur suddenly or if they can be anticipated (for example, the appreciation of the yen or the oil shocks), make rules beforehand that will help you respond to

- a change in profitability of 5 percent or more
- a temporary halt in ongoing equipment investment
- a change in the investment budget

Once a report has been made, the accounting department should continue to monitor the situation closely.

The philosophy behind these procedures is the same as that behind the control chart. While this book does not explain control charts, readers can refer to any text on quality control for an explanation.

Improving the Effectiveness of the Budget Implementation Process. From a QC standpoint, implementing a budget depends on the relationship between the details of the budget itself, the management of the department implementing the budget, and the responsibilities and authority of the managers.

Japanese business management is characterized by a family-type organization that makes decisions and assumes responsibilities as a group. Even so, the procedures for implementing a detailed budget require that the different jobs and different operations be handled in different ways. This means that authority and responsibility must be clearly defined. This is true for rapidly emerging enterprises as well as for older, established companies. Figure 4.2 shows how one company defined its operations.

Although these rules may appear well defined, interpretations of their application to ongoing or unexpected purchases still differ. When negotiating a new deal, for example, it may be necessary to exceed the ¥10,000 limit for business expenses due to other policy considerations. Moreover, when subordinates circulate requests to people with decision-making authority for their approval, it can be difficult to distinguish who is drafting the proposal from who is approving it. I have seen cases in which an employee in a shop of 50 cannot spend a single dollar without getting the shop manager's approval. Standardization simply does not exist.

Operating regulations (division of operating responsibilities)
Department X Section Y Notes on Z

(Example) Materials purchasing section
1. Notes on purchasing materials for production
2. Notes on ordering components

Regulations on job authority (decision-making authority):

Business expenses (per item)	Department head	up to ¥50,000
	Section head	up to ¥10,000

Purchases:

Primary materials (per item)	Department head	up to ¥1 million
	Section head	up to ¥200,000
Secondary materials (per item)	Department head	up to ¥200,000
	Section head	up to ¥100,000

Budget (January–June):

Business expenses	Department X	¥600,000
Primary materials	Steel plate	¥1 million
	Electric cable	¥100,000

Figure 4-2. An Example of Company Operations

When a management structure does not properly define responsibilities and authority, the result is a collective organization that depends entirely on interpersonal relationships. Such an organization only goes through the motions of business planning, management, and budgeting. It can neither move efficiently toward a goal nor pinpoint strategies for self-improvement.

A budget cannot be implemented efficiently unless responsibility is defined clearly. Moreover, if a problem occurs over money, the person handling it will have assumed too much responsibility, while the manager will be held responsible for not having exercised proper managerial authority. In short, where responsibility is not defined properly, methods for making improvements will not be found. (For an explanation of this problem, I highly recommend *The Essence of Failure* by Yoichita Kobe, a Japanese book published by Diamond Publishers, which illustrates this point using the defeat of the Japanese Imperial Army in World War II.)

While the proliferation of computers has helped professionals keep pace with a rapidly changing economy, it also has blurred responsibilities and authority for implementing a budget. On the whole, computers have not improved efficiency.

We finish this chapter with some important points on clarifying responsibility and authority:

1. Break down budget details as much as possible in order to clarify responsibility. Have people at higher levels handle general project expenses — miscellaneous expenses and expenses that are difficult to categorize. Explain each step of each operation clearly so that everyone will know their authority and responsibility regarding implementation of the budget.
2. Budgetary authority, even among peers, should depend upon the nature of the job and the purpose of the expenditures.
3. Clearly specify the delegation of responsibility and authority in a manual, including the procedure (delegation from the department head to the section head, from the section head to the group leader, and so forth), the areas of concern, and the dollar amounts. It is essential that the manual teach employees both how to implement a budget and also what superiors will check on once the

budget has been implemented. The accounting department should help write this manual. Apply the management procedures described in Part I to this process — and think about the people who will be trained as your successors when designing and teaching these procedures.

4. The above discussion of the approach, procedures, and authority of the accounting department in the budget implementation process may seem tiresome. This is, however, the role and function of the accounting department according to TQC's Do stage. A plan for the most efficient implementation of the budget would require each department and every level of the company to understand this. These approaches and procedures are not performed because the accounting department is stingy or enamored of the power that comes from controlling money. The objective, rather, is to build a foundation for TQC in business management.

To reiterate, the role of the accounting department includes collecting data and information from many sources, processing the information so that it can be digested by anyone in the various departments of the company, helping other departments make surveys, and making the entire company aware of accounting's role in company operations.

Checking and Accounting TQC

Checking and Controlling. In Japan, financial management is thought of in terms of three steps: planning, regulation, and control. In his book *Financial Management*, Osamu Nishizawa defines control as "guiding financial activities, making regulations, and devising measures for improving financial efficiency in order to meet a certain financial standard (budget, price standard, and so forth)." Management is also thought of in terms of planning, guidance, and control. Kunihiro in *Fundamentals of Financial Management* defines control as "evaluating and reviewing the results of implementation." We can understand management as establishing a goal, an orientation, and controls — with an emphasis on the latter. In financial management, budgetary controls play an important part and are the responsibility of the accounting department.

Budgetary controls can be defined in several ways. They can refer to (1) control through adherence to a budget or (2) control through an analysis of the discrepancies between the paper budget and the budget as it is implemented. We see control methods expressed in the way the accounting department carries out *ex post facto* controls once the budget has been implemented, in the line control methods used by the department implementing the budget, or in an overall control method that combines these two. Budgetary controls and financial management are important facets of management. Budgetary control means keeping expenditures strictly within budget guidelines by comparing planned costs with resulting costs, and using their analysis to improve management. Strict accounting of every penny spent has made the accounting department very powerful.

The Plan stage in TQC's P-D-C-A system means that, in addition to setting specific quantitative goals, we establish standards and methods for achieving those objectives. This means that the subsequent "Do" step is not simply setting goals and leaving it to the individual to figure out how to achieve the objective. It means teaching workers about standards, methods, and their implementation.

At TQC's Check step we determi. ɛ whether the established standards and methods have been adhered to, compare the results with the plan, and check to see if the standards and methods are appropriate. Merely comparing the results with the plan is not enough to indicate what went right and what went wrong.

"Control" and "Check" have different aims. Check means a straightforward inspection or evaluation of the situation — for instance, an examination of how the budget diverges from reality. This enables us to judge whether established standards for achieving the plan have been followed and whether the plan is suitable.

The plan and the methods for its implementation are fundamental. The Action step involves standardizing methods, writing manuals, and making various improvements to upgrade standards and quality.

Before deciding a course of "action," we must evaluate the results of budget implementation (Check) and consider:

- possible effects of the action outside the context of financial controls
- specific cases of training, distribution, and material costs
- cost management
- miscellaneous issues
- achievements and company responsibilities

What Checking Means. Let's consider budget implementation from the perspective of TQC standards and methods.

One view holds that budget implementation is the sole responsibility of the various departments that carry it out. By this logic, the accounting department should not get involved in the details of standards and methods but should confine itself to planning the budget and analyzing the implementation results.

A second view holds that accounting should be thought of as managing the financial side of a business. For example, let's say a company increases its market share, is unable to meet its sales plan, and finds it hard to make a return on capital. This could force the company out of business. If a company fails to provide the anticipated return on capital, its credit rating will drop and financial backers will be hard to find — regardless of its increased sales. From the perspective of capital — the more budget controls, the better.

A third group believes that companies caught up in today's rapidly diversifying and shifting economy should rely on capital management with controls to determine the best steps and measures to employ.

Finally, others think that accounting cannot adapt to TQC methods — that it is an established, specialized field with a developed body of theories and approaches that is not conducive to being managed and checked in the same way as other business activities.

The Check step in accounting means comparing the plan to the outcome. Checking might reveal the inadequacy of the methods evaluation. With this in mind, let's consider how the Check step might change the situation.

Accounting uses monetary values to guide management. These checks differ from the checks the manufacturing department performs to make sure that its products meet standards. It would be difficult for the accounting department to find a basis other than money for comparing a plan and its implementation.

The goal of budget implementation is to establish a system that will make the company a going concern. This means maintaining its leadership in the market, developing new products, and opening up new markets. Medium- and long-range profits must be protected. Therefore, the first consideration in checking a company's budget implementation is to determine how well it has served these objectives. The extent to which it has done so determines the achievements of the company. Once you have checked the actual objectives according to the business plan and the suitability of the budget, the next step is Action.

The accounting department can leave to computers the tasks of analyzing the budget and comparing it to the actual results.

Accounting's role is to use monetary values to evaluate how well the budget goals have been met, to measure the plan's costs and efficiency, and to see that business details are carried out and future business planning is not forgotten. Accordingly, the Check step calls for a stricter supervision of business activities than does Control. Accounting helps the department executing the plan by analyzing the details of budget implementation. The accounting staff should always be aware of how much these analyses help top management.

Companies more than ten years old but still not well-established account for a large proportion of recorded company failures. As seen earlier, however, poor sales — not poor management — is usually the reason for these failures. This means that these companies failed to improve their primary products. A company that focuses on superior technology and ignores market trends may succeed for a while, but it will certainly falter over the long term.

I think many companies find themselves in this position. I also believe the advisory role to management of the accounting department's Check function will increase in value, especially since we hear more and more today about the failure of businesses both large and small.

This explains why the implementation of accounting TQC, the foundation of management planning, is different from manufacturing TQC. In accounting, the Plan and Check stages are the most important functions in TQC's P-D-C-A program of management planning. Once we understand this, we should no longer stress Control but instead emphasize the Check stage. Once this is accomplished, we will have begun to make TQC central to the operations of the accounting department.

The Cost of Training. Although training is primary in personnel management and management planning, checking how money is spent on training is difficult. This topic extends discussion of the training budget (Chapter 3) and is a precondition to making training decisions.

Although training expenses usually are included in a cost budget, they are a very special kind of cost. Although training expenses break down into categories such as costs for personnel, training materials, and lectures that are charged to the current year, the results of training can only be evaluated several years later.

Therefore, the effectiveness of training relative to its cost is difficult to determine. We should think systematically about training expenses and evaluate them with respect to the company philosophy before drawing up a budget.

This is true for equipment costs as well. However, equipment costs are visible and their effectiveness can be calculated beforehand, while training expenses remain invisible and difficult to understand.

Training theory will be discussed in Part III. Here I will try to explain how we can use the Check step to evaluate training effectiveness.

Required training expenses. The expense of teaching company regulations to new employees and of sponsoring special training events is part of the cost of doing business. Pay close attention, however, to training involving work standards and manuals related to company activities. I will discuss this further in Chapter 8.

Training costs of work and product information. Teachers, texts, and training materials should be well prepared; educated employees are the foundation of your business. Test results are a good way to measure training effectiveness, but they should be evaluated according to their relationship to the person's success on the job. The relationship between the training program, job performance, and skill improvement should be checked.

Costs of training supervisors and managers. Training supervisors and managers is an important part of any company's training program; it should always be part of medium- and long-range planning. This type of training, however, is hard to evaluate. Improvements in personnel training and higher job achievements will best indicate the success of a company's training program.

Although the personnel department has primary responsibility for training programs other than those carried out within the various departments, top management can strongly influence their planning, execution, and evaluation. In addition to evaluating training and checking the results of the training budget, these executives should examine medium- and long-range plans from a human resources perspective as well. It is important that the accounting department work with top executives as well as with the personnel department to evaluate and check the effectiveness of training spending.

A good way to train supervisors is to have them serve as QC circle leaders. People serving in this position develop group leadership skills and learn how to write manuals that are easy to understand and maintain. Another good way to train managers is to delegate the responsibility for developing work standards or carrying out a project to management trainees. This will be discussed further in Chapter 6.

Distribution System Costs. There are four general categories of business operating costs:

1. management planning costs (including marketing costs and general management costs but excluding manufacturing costs)
2. management costs and general management costs (excluding incidental costs)
3. costs other than manufacturing costs (including interest payments and other incidental costs)
4. consumption costs directly related to marketing activities (including distribution costs within the company and other costs directly related to marketing incorporated in the manufacturing costs)

The second category is used usually to calculate the overall price, while the fourth category is better for managing the various kinds of business costs. Although the Japanese government's agency for small and mid-size companies has established a way to calculate these kinds of expenses, Osamu Nishizawa, in his book *Financial Management*, states that classifying business costs by function is preferable for management purposes. I don't use the marketing costs category, however, and prefer to analyze these costs as distribution system costs. (See Figure 5.1.)

The Japanese distribution system is incomprehensible to most Europeans and North Americans because of its rebates; freedom to return unsold goods; delayed payments; assistance to suppliers during transitional periods; frequent deliveries; and strong ties between manufacturers, wholesalers, and retailers. To reduce the distribution costs of such a system is difficult. These traditional trading practices are tied intimately to Japanese history and society, making them very difficult to alter.

- Marketing costs
  - advertising and publicity costs
  - sales promotion costs (rebates, entertaining costs, etc.)
  - sales personnel costs
  - other
- Distribution costs
  - packaging and wrapping costs
  - loading costs
  - transportation costs
  - storage costs
  - other
- General management costs
  - broken down by department, etc.

Figure 5.1 Classifying Business Costs by Function

Distribution costs, however, figure strongly in any strategy for reducing business costs. As large distributors have taken their place in the Japanese marketplace, U.S.-style streamlined business operations have appeared. This trend is particularly noticeable in the retail industry. Distribution costs cannot be determined as early as manufacturing costs. The time lag involved in getting information on business costs such as marketing and distribution costs causes problems.

These considerations illustrate the importance in business strategy of distribution cost checks by the accounting department. These accounting checks are not a thorough examination of the final budget but a careful study of the budget as it is developed — with particular attention paid to the standards applied at each step of the budgeting process. Following this, it is essential to pay close attention to distribution costs to check the distribution system.

It is also good to compare the distribution systems of our company with its competitors and even with companies in other industries. To promote this "distribution revolution," other factors such as vendor enthusiasm, point-of-sale (POS) utilization, and changes in the marketplace should be evaluated.

Today, we are living through important changes in distribution philosophy. This has more to do with the business management system than with distribution costs. Tax reforms, such as the value-added tax, bring important changes in the distribution system. Companies should monitor closely the strong influence on business operations exercised by the management of distribution channels and distribution costs. The power of accounting TQC is demonstrated by the accounting department's role in reforming the substance and structure of the distribution system.

Distribution Costs. I don't need to explain just how important distribution has become in recent years. We can see this in faster deliveries of fresh food, for instance, as well as in the effect on costs in other areas. Reducing distribution costs builds profitability.

We should consider the following issues when itemizing distribution costs. Although distribution costs appear in one place on a balance sheet, they break down into different components. Although "payment for freight charges" appears as one item under marketing and miscellaneous management costs, this single item includes:

- raw material costs attributable to delivery costs;
- manufacturing costs attributable to distribution costs within the company;
- marketing and general management costs attributable to marketing and distribution costs;
- incidental costs attributable to interest payments on capital tied up in distribution within the company; and
- distribution costs that include storage, transportation within the company, packaging and wrapping, external transportation, and unwrapping and disposing of waste materials. (Distribution costs should be seen as a continuum.)

Anticipate the following dialogue (or its equivalent) when discussing distribution costs in a factory:

> *The factory says,* "I understand the difference between a budget on paper and actual results. What I don't know is how these changes break down and the reasons behind them. In order to reduce costs, I need to discuss them."
>
> *The manufacturing department says,* "We've reduced manufacturing costs according to plan. The larger inventories and higher transportation costs, however, are the responsibility of the sales department."

> *The distribution department says,* "Higher distribution costs naturally result from larger inventories. That's the sales department's responsibility. The accounting department should stress analysis and methods for making checks beforehand."
>
> *The accounting department replies,* "The distribution budget should vary with sales. The planning department should make adjustments in the relationship between sales and production."
>
> *The sales department says,* "We are working day and night to solve this problem, but a volatile market makes it very hard to know what will sell. This issue, however, is separate from distribution costs."

These are familiar scenarios. Although distribution costs affect many different departments, there is often no strategy for developing a budget that accurately takes them into account.

Distribution costs are influenced by many factors, including (1) the number of stages in the distribution process (closely related to how frequently goods are transported); (2) how packages are wrapped and put in bundles for shipment, the packing materials and especially their disposal after the package has been unwrapped (environmental protection makes this an important problem); and (3) the mode of transportation (determined by the type and shape of the product and how it is packaged). The accounting department should manage these different costs comprehensively, as a single unit.

It is a demanding task to manage distribution costs that range from a product's initial production to after it is sold by the retailer. Computers make it much easier. We can determine actual sales by checking the relationship between inventory expenses and distribution costs. [Note: The "Unified Standard for Explaining and Calculating Distribution Costs," published in 1977 by Japan's Ministry of Transport, tells how to calculate transport costs and is conveniently divided into a sections for manufacturers, wholesalers, and retailers.]

People often talk about the multiplier effect of distribution cost reductions. Here is an example of that effect:

> If distribution costs are 10 percent of sales, then annual sales of ¥1 billion work out to distribution costs of ¥100 million. Reducing this ¥100-million figure by 10 percent boosts

profits by ¥10 million. If this ¥10 million profit accounts for 5 percent of the profit on sales, it is equal to ¥200 million or a 20 percent increase in sales.

This example illustrates the great importance of distribution costs. The comprehensive checks and the multiplier effect just described can be called the TQC "Check" approach.

Note: *Business expenses and the Robinson-Patman Act.* The Robinson-Patman Act, proposed by Congressmen Robinson and Patman and passed by the United States Congress in 1936, stipulates that if a company sets different prices for the same product in different regions, the differences in business expenses must be clearly stated. Japan is such a small country that business expenses probably vary little from region to region. Therefore, in Japan there is competition for sales, market share, and access to new markets, which can result in sudden price drops. As manufacturing costs and product quality become more uniform and brand names become less important, many companies strive to cut costs so that they can lower prices while maintaining profitability. I believe the Robinson-Patman Act addressed a different concern. Distribution costs and wholesale costs should be considered not from the conventional control perspective, but from the perspective of the Check step.

Cost Management. TQC's Plan-Do-Check-Action steps have been described many times. Views differ, however, on how to apply the Check step to the most typical TQC problem — cost management. Accounting methods usually used on cost management problems have a strong control bias, incorporating different analysis methods. To analyzing this problem, let's compare TQC methods with control methods.

First, we must define cost management. According to the cost management report of MITI's Industrial Structure Council, cost management is an aspect of profit management that involves determining the cost reduction goal necessary for steady corporate growth, developing plans to achieve that goal, and performing management activities to fulfill the goals of the plan. This takes a much broader view of the problem than does the simple control approach. The simple control procedure is not as explicit as the TQC management cycle, although it addresses the same issues as TQC. Accordingly, if we consider that TQC arose from managing quality, quantity, and costs in manufacturing, we can see that TQC can be applied readily to the field of cost management.

In fact, cost management is an unavoidable part of TQC accounting. Because there are many examples of both the accounting aspects and TQC aspects of cost management or cost reduction, I don't need to address them here. Instead, we will examine the most basic type of TQC — how to apply TQC tomanufacturing costs.

Actual costs and standard costs. Although financial accounting and management accounting use different calculation methods for cost management, corporate accounts must be recorded according to the actual costs specified in the tax code. The interim report of the Business Accounting Council of Japan's Ministry of Finance points out that cost calculation was developed in order to display the correct cost when designing various tables and to furnish information for calculating prices. As cost calculation methods that management can use to plan operations and manage costs have developed, the importance of standard costs has increased.

Standard costs are central to the development of TQC in cost management. They can even be anticipated by applying the standard of efficiency using a scientific, statistical survey of consumption. In addition, we can calculate costs based on the anticipated or normal price. This makes price a TQC standard for cost management.

According to Japan's tax code, if the difference between the standard cost and the actual cost incurred (or cost differential) in business accounting of daily operations is 1 percent or less of the total manufacturing expense, an adjustment is not necessary. Dealing with standard costs is very difficult for small and mid-size companies. Therefore, it is important to proceed with care when choosing cost goals according to the tax code standard without first referring to TQC standards.

Cost goals and TQC. Cost management must keep the margin between standard and actual prices within the limit stipulated by the tax code. If the standard cost falls outside the specified range and a cost goal must be set, it would be unwise to adopt a goal of 10 percent less than that of the previous year. It would be more productive in the long run to use QC methods to solve such a problem.

The very nature of TQC requires that a standard cost (or any plan or goal) be set based on QC methods and analyses that make plans and calculations based on real data. Accounting plays a primary role in building a solid foundation for the promotion of these calculation methods and plans within the company.

The following is a summary of the fundamentals of setting a cost target:

1. Use only reliable figures when setting a cost target (standard). Use figures more optimistic than the results of the previous period only if improvements made as a result of QC activities have been rigorously tested. Although these cost targets might be met for a time, we still have far to go before a standard cost system is established. QC can be established only by actually writing a manual describing the improved methods.
2. While QC can produce improvements in one area (such as a workshop), lowering overall costs, coordinating the entire system, and checking is the task of accounting.
3. Set the cost target scientifically. In other words, perform difference analyses on the results and make improvements on the basis of these analyses. Analyze the differences between the cost target and the actual results and manage the cost target according to QC principles and methods. TQC cost management means going beyond the formulas shown in Figure 5.2 to discuss and revise the procedure for setting cost targets.

Difference analysis formula for direct material costs	Price difference = actual consumption × (the difference between standard price and actual price)
Difference analysis formula for direct labor costs	Wage rate difference = actual operating time × (the difference between standard wage rate and actual wage rate)
Difference analysis formula for indirect manufacturing costs	Utilization difference = (standard operating time × standard wage rate) − amount budgeted for standard operating time Manageable difference = difference between the amount budgeted for standard operating time and the actual amount spent

Figure 5.2 Formulas for Analyzing Differences in Standard Costs

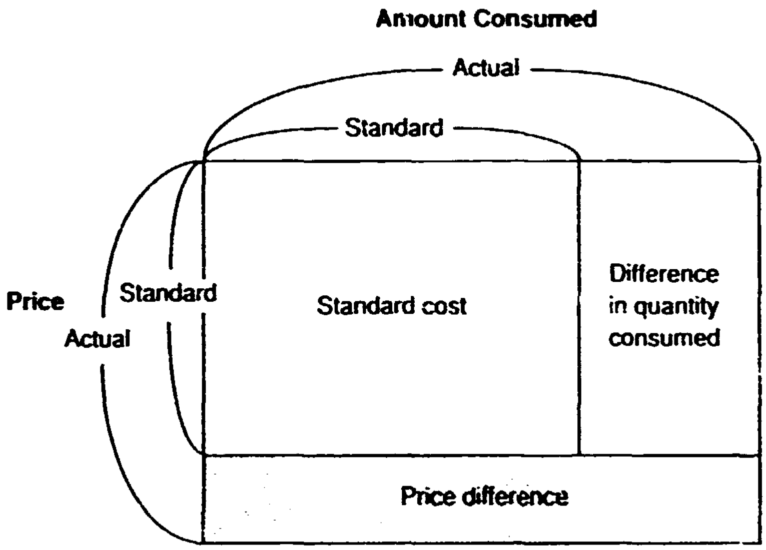


Figure 5.3 Difference Model Diagram for Direct Material Costs

4. QC methods make it easy to compare differences in material costs and direct labor costs, and many textbooks have been written on this subject. Analyzing variations in the cost of different operations caused by indirect labor costs is difficult. With the rapid changes and increasing diversification of today's economy, the standard cost system becomes more difficult to use because it was not developed with the production of a variety of products in small lots in mind. Marketing is concerned with the rate of capacity utilization since it is directly related to inventory and sales. Therefore, we can expect the business and manufacturing departments to argue over the rate of capacity utilization. A management system based on a standard cost system and anticipated prices should establish a rule that standard and target values be revised every three to six months for the entire flow of production — from manufacturing to the customer. Fortunately, computers make these changes relatively easy to handle.

Process costs and individual costs. There is often disagreement over whether a particular cost is a process cost or an individual cost. Manufacturing strives to manage individual costs as precisely as possible, while accounting looks at the overall picture in terms of process costs. Computers might seem to solve the problem of tracking costs more precisely, but as smaller quantities become involved, the conditions necessary to perform such calculations become more demanding. As changes in the rate of capacity utilization alter the amount that should be allocated to general expenses, it is not enough simply to calculate and manage more precisely. The accounting department must make decisions based on rational levels of detail and suitable combinations of general and individual accounting of specific sections.

Total costs and direct costs. In actual and standard costs, the over costs that occur in the manufacturing and marketing sectors are calculated together. We call this "total costing." While total costing is required in financial reports, direct costing is an excellent cost management method. In a cost management report, MITI's Industrial Structure Council defines direct costing as a way to distinguish between the fixed and variable costs related to the cost of manufacturing and marketing a certain quantity of a product. Only the variable cost is used to calculate the manufacturing cost. The fixed cost is a periodic cost charged against the total income realized during that period. According to total cost accounting, if inventories change, costs and profits can vary even if sales remain the same. Falling profits that coincide with an increase in sales is a sign of poor cost management. Accordingly, calculating the marginal profits from sales while excluding variable costs is a good way to select products and simulate increases and declines in sales.

The essence of the approaches just described is the same as that of the standard cost problem — how to improve management by implementing a cost management program that combines business accounting procedures and measures stipulated by the tax code. At this point in our discussion, the question of how to apply QC techniques to management is especially important. As the primary force behind a company's TQC program, the accounting department will have to change some of its traditional cost accounting methods. This area in accounting TQC requires further work.

General Notes. As we have seen, the accounting department has to build a consensus in order to achieve management's goals and fulfill the corporate plan. To do this, as it checks on the implementation of the budget, it must be available to help the various departments implement the budget and improve their operations.

The following are some suggestions on how to carry out these checks.

The budget report. A budget report should reflect four qualities: accuracy, promptness, clarity, and responsibility. Accuracy is, of course, the most important. Promptness in reporting manufacturing and other costs, however, is a close second. And while business standards, clarity of format, and computers are essential to the operation, a budget report that focuses only on how each penny is spent without addressing the question of responsibility is deficient from management's standpoint. Organizational problems, division of labor, and management's responsibilities and authority must be considered when changing the management system. This issue is discussed in greater detail in Part III.

The accounting department's contribution. I have stressed that the role of the accounting department goes far beyond checking calculations. It extends into contributing to better management of the budget implementation process. We have already discussed the relative ease of budgeting and explaining training outlays. Outlays for opening up new markets and for developing new products, on the other hand, are not as easily explained.

Opening up new markets. Rather than thinking of new market opportunities in terms of faraway places, we need to put most of our effort into nearby markets we have never visited and into luring customers who have never given us an order. This is not only inexpensive but very effective. We should evaluate this contribution to sales independently of the contribution made by our efforts to open up markets in foreign countries.

To build a broader customer base (and thereby increase sales and market share) in an already established market is not simply a matter of stepping up advertising. This kind of project demands time and considerable effort to understand the market and to evaluate the company. The accounting department can check (1) the effect business spending (such as marketing and marketing-related activities) has on the company's image among the customer target group, (2) the increased number of sales calls, and (3) the relationship between the budget and business activities.

With a TQC approach, the accounting department is more concerned with helping the sales department staff than with fastidiously checking the financial aspects of its operations. TQC requires the accounting department also to evaluate, together with the sales department, these intangible aspects of the Check stage.

Developing new products. Because a company's survival in the manufacturing industry depends upon its finding a niche for its products, many enterprises devote a large proportion of their budget to new product development. Make clear the orientation and specifics of new product development as the budget is prepared. Once a plan has been drawn up, check the new product development effort as it is implemented or at the end of the year. This review is important for two reasons: (1) because many development projects tend to go off in different directions and (2) because more money than was needed may have been budgeted for a specific project, with the excess ending up diverted to peripheral issues. In this case, accounting's role is not to determine how large the outlay should be but to serve as a detached observer who makes sure that the new product development effort is well organized and that the outlay is being spent properly.

Checking goal orientation. All budgets — whether they are zero-based budgets, project budgets, or budgets for plant and equipment — are developed with particular goals in mind. Manufacturing budgets have a large technological and methodological component with many operating plan expenses under the general expenses category. Moreover, once it is determined, the budget is implemented independently of other company operations.

When the accounting department checks the implementation of a department's budget, it should go beyond financial aspects to consider how the different budget components fit together. For example, twenty months may pass between the time a government agency develops a budget and the time it has been fully executed. In private industry, this period is about fourteen to fifteen months, and some six-month budgets are fully executed within eight months of being drawn up. While this may appear to be a short time, in today's volatile, fast-moving economy, any company that is not alert may quickly become as obsolete as yesterday's newspaper. The moral of my story: Make certain your company's budget is goal-oriented!

The importance of the accounting department's checking system cannot be overemphasized. Checks should occur at least once a year to evaluate the effectiveness of the various outlays and to help individual departments make whatever changes are necessary to the part of the budget they are implementing. The accounting department should also make sure that the various parts of the budget fit together well.

Evaluating Corporate Performance and Corporate Responsibility. Checking in accounting can be considered an evaluation of company performance in financial management. Naturally, financial management is the principal objective of accounting here, just as it is when budgetary controls are being carried out. We will examine this aspect of accounting later in the context of the radar chart method.

One cannot ignore corporate performance at the Check stage when judging a company's financial situation using an evaluation of its performance based on accounting methods. However, discussion of the standard indicators of financial health such as profitability, productivity, and safety will be left to specialized texts. Instead, we will take up the issue of corporate social responsibility, a topic that should concern every company carrying out TQC.

Recently, companies have begun being evaluated by their "ecological" marketing activities. Aside from the issue of pollution, company activities are being judged by their contributions to society in a broad sense. Under the umbrella of a standard financial evaluation, a company must demonstrate its social responsibility as well as profitability, productivity, and safety.

Although the social responsibilities of a company have not as yet been defined satisfactorily, they should include the following elements:

1. Steady development of the company
2. Improved work environment for employees
3. Environmental protection
   - pollution prevention
   - regional environmental protection
   - charitable contributions
   - scientific and technical contributions
4. Contributions to consumers
   - providing improved, quality products at reasonable prices

- attention to consumer needs
- accurate product information
- inexpensive delivery, improved delivery service

The fourth criterion for evaluation, the company's contributions to consumers, relates directly to the first and second as well as to problems of marketing and the company's day-to-day activities. A company can approach the third criterion, environmental protection, in one of two ways: ignore it and make no investment or expenditures, or embrace it and make voluntary contributions to fight pollution and protect the environment.

Of late, local governments and agencies have been collecting and analyzing data on pollution and then writing regulations (or making calculations based on a formula) using that data. In other areas, where the collection of information on pollution by region and by industry is desirable, this task often falls to a company's accounting department. The company contributes scientific and technical expertise and assistance to the community, for example, by providing neighboring companies with guidance and assistance on TQC and by sharing information and people with companies in other industries.

Although social responsibility is not a traditional concern of financial management, today's accounting department should be actively engaged in it — it affects company survival. Social responsibility is part of accounting TQC.

The Role of TQC at Each Level of the Accounting Department

The Role of TQC in the System. Before we continue, let's review the characteristics of TQC that were described in Chapter 2.

1. TQC involves gathering information on the condition of the marketplace and the business, uncovering the real issues by analyzing this information, and determining numerical values for policies, goals, strategies, and business plans developed by corporate management to address these and other problems.
2. TQC uses statistics, tables, diagrams, and other tools to explain company policies and plans and then assigns numerical values to them. In this way, people at all levels in every department will be able to understand the company's plans, policies, and objectives.
3. TQC provides methods for carrying out plans for error prevention. People on the front line responsible for executing the plan can benefit enormously by forming QC circles to carry out operations and improvement activities autonomously.
4. TQC improvements do not stop with solving a specific problem but aim to raise the general level of operations.

TQC systematically implements and continues the management cycle at all levels of the company. Figure 2.1 in Chapter 2 introduces the management cycle. Figure 7.1 shows how the management cycle is organized throughout the company at a later stage. Since the system is the same for the accounting department, we will refer to this figure as we examine the principle functions of each level of the accounting department.

The Role of Accounting's Top Level Managers. The top managerial level of the accounting department consists of a group of executives from the vice president in charge of accounting and directors at the highest level down to the individual department heads. While actual positions vary by company according to the size and nature of its business, top level managers are defined most commonly as managers at the department head level and above.

In addition to providing a foundation for business, accounting's top level managers play an important role in making business policies and plans. Our discussion here will build on that already examined in Chapter 3.

The primary responsibility of top level managers in the accounting department is to implement throughout the company the policies and business plans drawn up by the corporate management. Business is based on accounting — and since accounting is also the foundation of marketing, accounting's top level managers participate directly in the development of company policies and plans. The accounting department uses the budget to direct the implementation of the business plan from main provisions to details and needs top level managers to explain and implement it. To more effectively reach all levels of the company, they should utilize the statistical methods and graphs of TQC.

Accounting's top level managers also play an important role in the annual orientation of new employees. From an accounting TQC perspective, they can explain the deployment of TQC in company operations such as policy-making procedures or the relationship between product quality assurance and investment in plant and equipment. With the spread of computers, accounting's top level managers also are responsible for explaining the links between business management, business operations reforms, TQC, and computers. Thus, the TQC awareness of both old and new employees is lifted to a common understanding of why "total"(T) QC should be deployed throughout the company.

An important managerial responsibility at all levels in the accounting department, and particularly at the top level, is to clearly express the policies of corporate management in terms of departmental objectives and tasks. The accounting department should make certain that each department understands the strategy for accomplishing these objectives so that the corporate goals are reached.

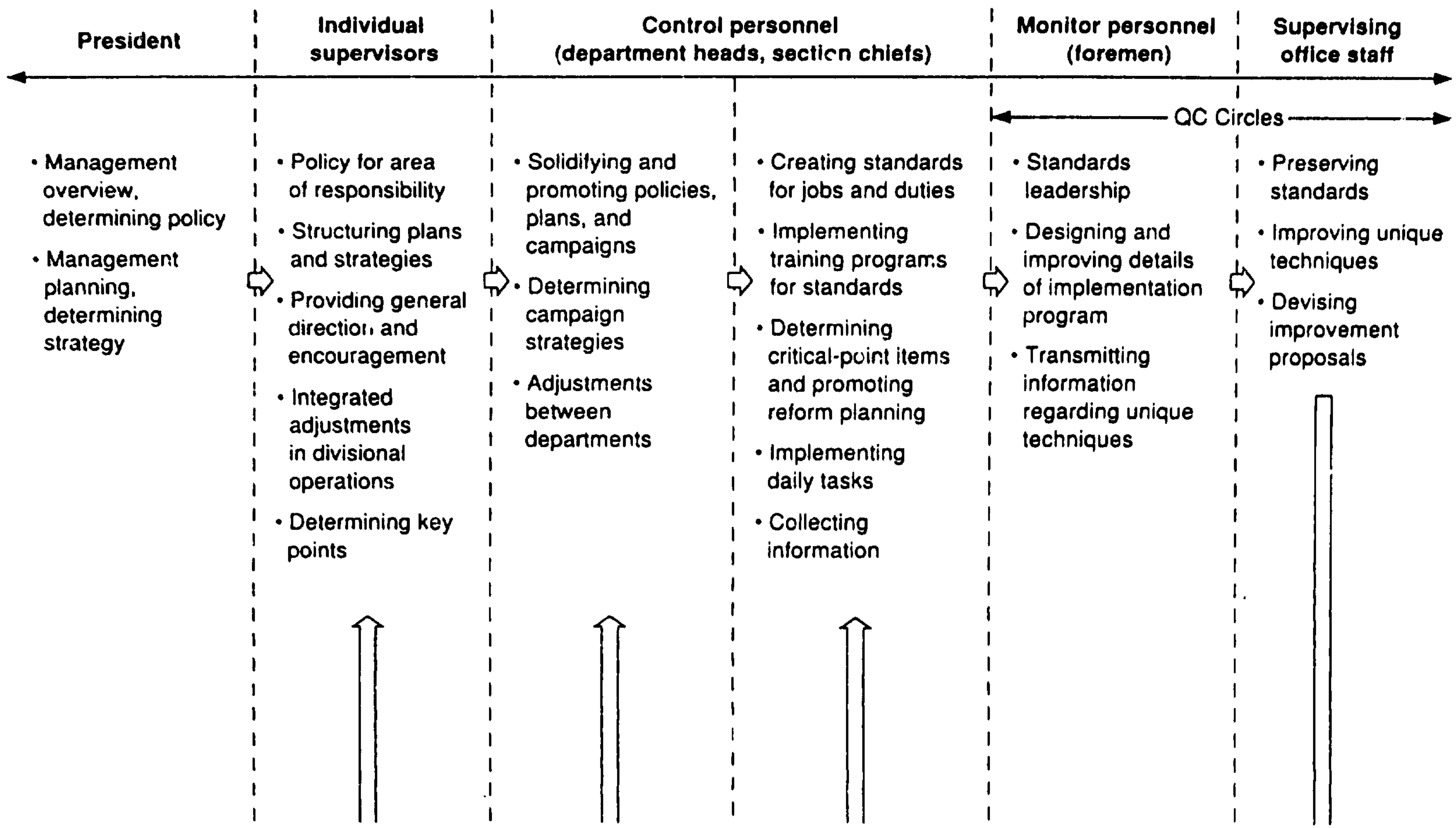
For example, if corporate management sets a policy of increasing sales by 10 percent while aiming at a maximum return on expenditures, accounting's top level managers must issue clear and specific directives to each department, such as where to reduce expenditures or which items must show sales increases in order to reduce the expenses-to-sales ratio. They are also responsible for making changes in the proposals submitted by each department.

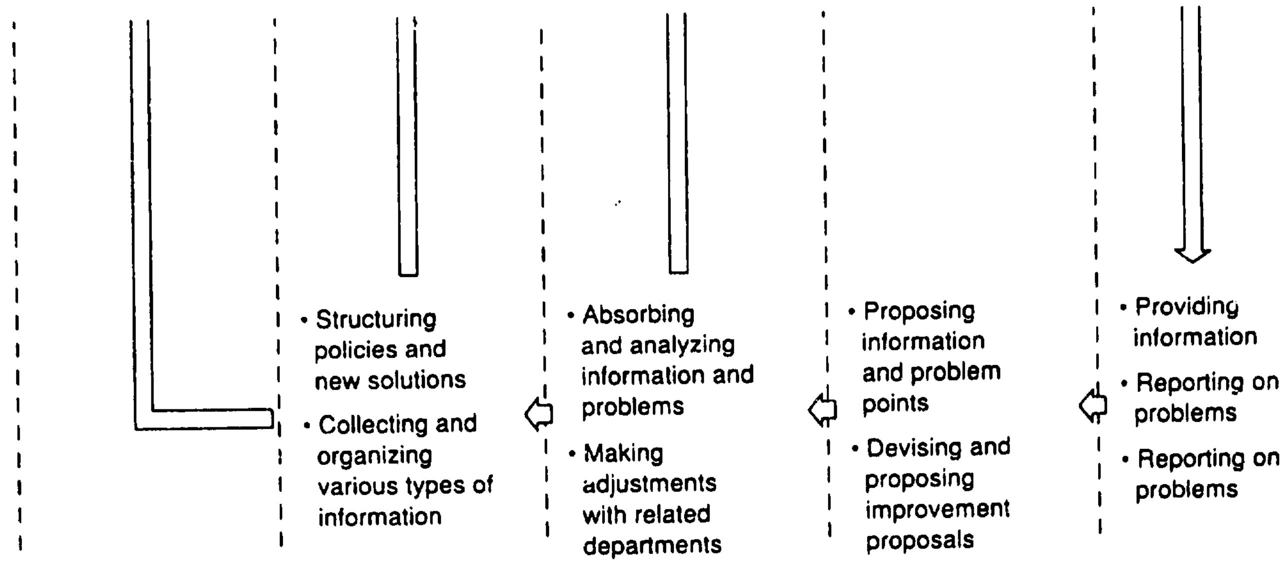
The adjustments made by the accounting department should provide instructions about specific projects and the implementation tasks to be carried out by various sections. They should also reflect the basic orientation of company policy, the state of the company's business, and market trends. A directive to increase efficiency and cut costs by 10 percent would lead to errors and take the company in the wrong direction. Specific interpretations of the directive are best worked out by the individual sections of the company.

A big job of accounting's top level managers is to use statistical QC methods to analyze the relationship between last year's sales and market conditions as well as to make cost breakdowns. They should explain the significance of their results using tables and diagrams that all employees can understand.

The sales department, especially branch stores and offices, are also deeply involved in developing a system to recognize social and economic trends early on and communicate them to the company. Those developing the system should decide what information to collect, the data collection methods, reporting procedures, and so on. For the sales department, however, these activities have a lower priority than the data and materials regarding sales activities. It is the accounting department's responsibility to take these trends and bits of information neglected by the sales department and teach the rest of the company what they mean and why they are important.

Responsibilities System Diagram for Each Stage





Note: Details concerning stages and jobs presume a standard type of organization.

Figure 7.1 Responsibilities System Diagram for Each Stage

The technical department as well as the sales department should present and teach information. It is particularly important that the technical department understand these social and economic trends.

In addition to collecting marketing information, the accounting department's top level managers should actively gather other information, such as financial data and new products being developed in other industries. This information should be used to develop and change budgets based on economic and business trends, enabling accounting's top level managers to assist corporate management in the management and operation of the entire company.

A principal function of accounting's top level managers is to promote company policies and plans with financial institutions and other outside organizations. While corporate management actively participates in this as well, an explanation of the company's capital, cooperating companies, profit-and-loss prospects, improved distribution channels, or contributions to the community are best left to the accounting department. The accounting department is also responsible for communicating requests for cost reductions from the manufacturing or purchasing departments to cooperating factories or requests for sales increases from the sales department to dealers. This must be handled with discretion to avoid stirring up bad feelings that could destroy the cooperative relationship. Explaining capital and anticipated profits and losses to cooperating companies, especially small companies, is a major responsibility that is part of the TQC promotion to be carried out in parallel with the internal execution of corporate policy.

Established methods of management training are vital at this stage. To train new middle managers, middle managers and specialized staff from all departments must have standard operation classifications that clearly define responsibility and authority. These classifications are needed to allow time for the information collection tasks and external promotion activities previously discussed. They also help lower level managers train their successors. Later we will discuss the relationship between standardization and delegating authority.

Middle Level Managers. As a rule, middle managers, such as section heads, spend most of their time involved directly in the actual operations of the company. We should keep in mind the following discussion concerning the direct implementation of company operations.

Although the division and flow of work is well defined in accounting operations, who gets what from whom is hard to determine because responsibility and authority are not clear. There are many examples of this. In handling cash, depending upon the sum, some cash payments might be taken care of at a level below the section head or chief clerk. There are different views on the amount of money that should be handled on each level. Even if the department and section heads decide to divide this responsibility in a particular way, it may not be easy to divide responsibility between the section head and someone at a lower level. The division will depend upon the section head's position. Moreover, the section head exercises some authority over this procedure by checking the contents and sum of the tickets written up by subordinates. As this task is formalized, however, authority gradually disappears and handling cash becomes the only unresolved issue. While the administration department may want to revise the operation when updating the job descriptions of section heads, responsibility should lie with the accounting department because it involves handling cash.

One of TQC's roles in the accounting department is maintaining contact with, supporting, and guiding the person responsible in each department for implementing the budget. In actual practice, this is the section head or chief clerk. From the standpoint of TQC and the marketing system, the other departments will recognize the basic role of business management only to the extent that the accounting department's middle managers maintain close contact with the departments implementing the budget.

The accounting department's primary operational responsibilities lie with middle management. The latter is responsible for creating, revising, teaching, and maintaining these rules and procedures, or standard categories. Directing operations could mean training workers to do calculations using an abacus, to write figures, or even to stamp documents. Entrusting these matters to a veteran employee and checking tickets yourself is not true TQC. The manager should personally teach the content, effectiveness, and maintenance of standards. Rather than managers, supervisors should decide how to teach material and how to make training more effective, as well as how to improve skills through practice in the regular operations of the company. The shift in accounting's central calculation technology from the abacus to computer systems has coincided with similar changes to the essentials of training and guidance. The work performed by an accountant must be assessed and revised in light of its relationship to all operations.

Managers should collect all types of data from both within and outside the company. However, since middle managers' role is similar to that of baseball's player-managers, they cannot circulate as widely as top level managers in an active search for information. Middle managers must concentrate on gathering information from people they regularly deal with, such as the representatives of financial institutions and collection agencies, and listening to what visiting bank representatives have to say. Important information about current market conditions is gained during these conversations. This information is in a different class from that of information obtained from people at higher levels. Today, a representative of a municipal bank makes about 600 calls per month — and gleans a great deal of information.

The Role of the Supervisor. Supervisors generally at the chief clerk level are coach-players responsible for seeing that accounting work is carried out according to legal guidelines and the company's regulations and manuals. Their duties can be broken down as follows:

1. The supervisor teaches and supervises the accounting department staff so that accounting operations are carried out according to the manual.
2. The supervisor uses personal experience to guide the accounting department employees so that the employees will understand the techniques and skills described in the manual.
3. The average employee is younger than previously and brings to the job new sensitivities and techniques. The supervisor should discover these talents and apply them to the work tasks. Remember that it is important to involve employees early in making improvement proposals in QC circles.

4. Although supervisors often assume leadership of QC circle activities, they should use the an opportunity to combine the sensitivity of younger workers with existing techniques and skills. The QC circle, therefore, is a platform on which to develop new techniques. The supervisor should learn as much as possible from the new, younger participants.
5. Many accounting activities begin with the installation of computers. This upgrade is an excellent opportunity to reform accounting operations (such as clarifying the authority for processing payment tickets) and to standardize related operations (such as setting the cutoff date for inventory ticket processing and standardizing payment dates. Those in the supervisory level and below are concerned with the problems of everyday operations and should recognize their responsibility to make improvements in operations to the best of their ability.

There are many issues to address when discussing the role of the regular accounting department employee. To really understand the perspective of supervisors as well as the role of QC circles, they would do well to study pertinent sections of this book.

Digestion and Absorption. So far, we have used the TQC perspective to examine the role of each level of the accounting department in carrying out daily work. We can summarize these roles as fulfilling responsibilities for carrying out corporate policies at each level by "digesting" them according to the responsibilities of each job.

For this to happen effectively there must be a clear chain of command. Watch out for dysfunctional systems of authority, however, the clumsiest being what TQC calls "tunnel command," where performance is not incorporated. For example, the company's president sends down an order — prevent fires. The department head repeats the order, "The president says to prevent fires," and it is passed on down the line without any specific instructions. As a result, the original order is not carried out and no improvements are made. This is why tunnel command is an ineffective instruction method.

"Digestion" means defining the division of labor, contents, and responsibility for an operation according to a policy and plan.

In this manner, a specific operation can be accomplished. This is just the opposite of transmitting an abstract and vague tunnel command instruction.

Therefore, "digestion" implies a communication loop from the top level to the bottom level and back for the purpose of asking questions, proposing improvements, passing on information, and so forth. The information, itself is not as important as getting the upper level of management to "absorb" the questions and information.

This communication loop determines whether problems are solved, whether interdepartmental coordination occurs, whether action is taken on the basis of external information, and whether adequate and rapid explanations are transmitted to people who make proposals. Even if the response fails to match the views of the original proposal, the important thing is how the matter was handled by the superior. The way this "absorption" is handled is a decisive factor in determining whether TQC and QC circles are vigorous and whether subordinates are enthusiastic about presenting their opinions to their superiors.

While it is not easy to implement digestion and absorption in the accounting department and in accounting operations, it is even harder to instill them in the manufacturing or sales departments. This is because accounting operations are more regulated and established as part of a system than are operations in other departments. The accounting department has an economic and moral duty to account for everything down to the last penny.

A special problem accompanying the smooth management of this kind of system is maintaining organizational morale and individual initiative. Although the sales department, for example, may have too many problem-solving themes, when we consider the accounting department's role as discussed in Part II, there are not that many themes to be absorbed. The most important issues are the role of TQC in accounting activities and how to actively promote its deployment in the accounting department.

Although "digestion" and "absorption" may be strange expressions, we use them to emphasize important aspects of TQC promotion. In explaining digestion and absorption, we should first consider the root binding system. This is a uniquely Japanese system in which the chairperson of a group of executives charged with making a certain decision circulates a draft proposal to the other group members for their comments and approval. Used in most Japanese companies and in government bureaucracy, it is not the circular communication loop system of making proposals using TQC, but a top-down system in which policy is set at the executive level.

Organizations long accustomed to operating by the root binding system do not understand the TQC management system described above. They tend to view TQC as a cost reduction process delegated to QC circles. If the root binding system's bad influence is blocking an organization's TQC management system, special attention should be paid to Table 7.1. This diagram illustrates the roles of managers at different levels in the accounting department. The accounting department should promote this system in order to more fully address problems of money and budget.

The Study of TQC. We have summarized the roles of each level of the accounting department from the perspective of TQC. To perform these roles efficiently, everyone must study to acquire an understanding of the characteristics of TQC and the ability to use basic TQC methods.

Since becoming popular, TQC has been equated primarily with QC circles. As a result, rather than studying the fundamentals of TQC philosophy themselves, executives and upper level management have pushed for the formation of QC circles. This often brings on a "QC allergy" among people on the front line. Therefore, in addition to QC methods and the Seven QC Tools, middle managers and staff should study the Seven New QC Tools and field methods such as testing, inference, multivariate analysis, experimental design, and operations research. However, the study of TQC's formal methodology may not be enough in some cases.

If people properly understand the actual meaning and characteristics of TQC, and the company makes step-by-step adjustments, TQC's expected results can be achieved. The topics that people at each level of the accounting department should study are presented in Table 7.1. A discussion of its most important points follows.

The managerial level and above. Although nobody in the accounting department at the managerial level and above is ignorant of marketing, when studying TQC, everyone should use basic texts to review the marketing system. This will help reconfirm the objectives of business management in companies applying TQC to

Table 7-1. Levels and Study Outlines for the Accounting Department when a TQC Program Is Launched

Level	Main Goals	Study Items and Processes
Top management (managerial class)	1. Relationship between management control and TQC (should focus particularly on marketing and TQC, and adjustments between sales control and personnel control) 2. Confirmation of TQC program progress status	1. The essence and philosophy of TQC 2. Promoting TQC 3. Statistical methodology (types and outlines)
Highest accounting supervisors	1. Constructing and promoting financial strategies 2. Promoting TQC in accounting 3. Adjustments between sales control and personnel control	1. The essence and philosophy of TQC 2. Promoting TQC 3. An overview of statistical methodology (at the same level of complexity as appeared at the beginning of this book) 4. The meaning of QC circle activities and their promotion

Control personnel in accounting department	Main office staff and section chiefs	1. Promoting TQC in your own department 2. Spreading TQC to the front lines, and absorbing problems 3. Advancement of information concerning economic conditions and management 4. Connections with other departments	1. Overall TQC knowledge 2. Leading and promoting QC circle activities 3. Statistical methodology
Control personnel in accounting department	First-line overall supervisory personnel (plant managers, branch managers, etc.)	1. Solidifying and promoting corporate policies 2. Structuring, developing, leading front-line strategies 3. Adjusting sales, production, personnel controls 4. Absorbing front-line problems 5. Connections with other departments	1. Overall TQC knowledge 2. Promoting QC circle activity 3. Statistical methodology overview 4. Marketing 5. Accounting knowledge
Control personnel in accounting department	Front-line supervisors (accounting section chief, etc.)	1. Solidifying and promoting policies of branch office managers, plant managers, etc. 2. Implementing QC circles and providing leadership 3. Reporting problem points to supervisors 4. Making adjustments in sales, production, and personnel controls; thorough implementation of training programs	1. Overall TQC knowledge 2. Promotion, participation, cooperation, and leadership in group discussion for QC circles 3. Leadership training methods 4. Statistical methodology
Accounting department members		1. Understanding the meaning of TQC 2. Promoting corporate policies 3. Implementing QC circle activities 4. Increasing efficiency and improving daily jobs	1. TQC overview 2. Methods of promoting QC circle activity 3. Statistical methodology

management and operations. If this systematic approach is neglected and only specialized parts of TQC are addressed by using TQC methods alone, or by only promoting QC circles, progress will not go beyond those areas and TQC will not reach its companywide potential. It is essential to realize that accounting operations are the foundation of all management and differ from partial solutions to product problems.

Studying examples of the effectiveness of TQC and QC circles is not enough. TQC advanced scientifically by using statistics as an approach. Proper understanding of the development, definition, and characteristics of TQC is necessary. Once upper management accepts the responsibility for its implementation, TQC will realize its potential and QC circles will come to life.

Middle management and staff levels. In the accounting department, middle managers and their staff know a great deal about financial tables, taxation, inventory control, and related topics, and apply this knowledge in their daily work. People at this level tend either to view TQC either as a collection of statistical methods worth understanding or to think the older accounting methods are adequate and to passively resist TQC.

Middle management's objective in studying TQC is to transmit the great body of accounting knowledge, philosophy, and methods to other departments. In addition, this group is responsible for the increased efficiency of accounting operations in the accounting department. To achieve these goals, middle managers study topics such as the methodology of the seven QC tools. This does not involve the same outlook used in data collection or the manufacturing department's stratification method or even the conventional approach to accounting materials. The heart of this approach is studying the nature of marketing. (Refer to Part IV for more on this point.)

As the middle managers study TQC, they should be concerned with the implementation and orientation of TQC into the manufacturing and sales departments. This, of course, should always be done with an accounting perspective. For example, if the sales department plans to increase sales, the distribution channels must be improved and the distribution costs lowered. The middle managers then should study such questions as how to apply TQC methods to different aspects of the problem at the same time and then determine what data the accounting department should collect and process.

Accounting department employees. The most important aspects of QC to ordinary accounting department employees are practical matters such as preventing errors and reducing the time needed to carry out operations. Therefore, the themes of their QC circles usually involve QC methods, in which studying the statistical approach and the seven QC tools (omitting control charts and histograms to save time) is sufficient. More material can be added when themes and the progress of the QC circle require it.

Throughout the ages, accounting operations have meant making calculations. Thus, accuracy and speed on an abacus has long been the measure of accomplishment. However, with the increasing mechanization and computerization of office work plus a growing number of accounting and tax offices in the service industry, the nature of calculations and bookkeeping has changed. The focus of accounting operations is shifting from skill in calculating and bookkeeping to inspecting tickets and making statements of accounts. Accounting department personnel studying QC methods are being reoriented toward statistical charts and tables and toward making decisions based on the data contained therein. This requires that today's managers and inspectors be well versed in these areas and able to guide accounting department employees throughout their studies.

Accounting department employees are receiving extensive computer training in order to rationalize and computerize accounting department operations. This training should stress the following points:

1. As explained when we discussed the role of supervisors, standardizing accounting and related operations is a prerequisite to computerizing them. Accordingly, the characteristics of TQC — particularly the P-D-C-A cycle — should be reviewed and the operations that affect accounting throughout the company should be standardized. Researching the question "What is standardization?" is the first step.
2. Again, emphasize the role of the accounting department in TQC (discussed in Part II). Study the relevant accounting process to determine what materials to provide to which department at which stage.
3. Next, employees should study how to print out accounting information using a simple graphing program (or by making a skeleton diagram). Most accounting programs

on the market today are capable of creating and analyzing financial tables and charts. Few programs actually analyze sales, product structure, and profits and losses. Therefore, companies have no alternative but to make their own skeleton diagrams, assigning the responsibility to workers in the accounting department.

4. Similarly, accounting materials such as capital utilization tables, financial analysis ladder charts, or plant investment calculation accounts are not easy to work with. Accounting department employees should study the statistical philosophy and methods of TQC so that they are able to apply them to these materials for easier comprehension. While studying how to work on these materials, they should always keep in mind the convenience of the "consumer" of the materials. These topics are themes for QC circles.

QC Circles

The Significance of QC Circles. By 1975, we had entered a boom period as far as TQC was concerned. It was thought at the time that QC circles were embodiments of TQC. There was lots of competition between companies regarding the number of QC circles in place, their meetings, and the amount of money saved by improvement proposals. One might easily have come to the conclusion that the QC circle in and of itself constituted the entire usefulness of the TQC concept. After two or three years of QC circle activity, however, a number of firms began finding their ways into more fundamental TQC programs. While this had positive significance to TQC programs as a whole, the downside was that QC programs tended to stall out, existing in some cases in name only, leaving many firms with no real sense of what to do with them next.

Many companies in the manufacturing industry had real success with their early QC circle activities. While these activities alone had brought about some significant effects, such was not the case in sales — especially retail sales. A significant number of such companies were left with programs that fizzled out before they really got started. This is the natural outcome in cases where (1) QC circles have been instituted just because such activities seem to be the right thing to do at the time, or (2) the formulation and promotion of TQC activities are thrust upon the company's rank and file by managers who themselves have not fully studied the concepts of TQC or planned for its use. This trend is not limited to companies engaged in sales; it can also be spotted in the sales departments of the manufacturers. The average corporation sees this phenomenon in workplaces with a relatively small number of people, such as administrative support, product development, and the like. In particular, it is seen in accounting departments.

At this point let us return briefly to the basics to clarify what QC circles actually are, as opposed to what they are not. This rehash is necessary for those managers and upper level administrative personnel who think that TQC is nothing more than QC circles, and for the members of various accounting departments in the manufacturing industries, who have tired of this particular vision of the QC circle.

The meaning of QC circles. In Chapter 2, we covered some of the characteristics of TQC. These can be summarized as follows:

1. TQC utilizes statistical methodology. Data is used to assess the current situation and make judgments about it. This same data is then used to draw up statistical charts and obtain the common understanding of all members of the workplace.
2. TQC is a form of "control" (P-D-C-A). It thus places special weight on methodology and the creation of standards.
3. By combining these two characteristics, it is possible for top management to achieve full acceptance and understanding of its policies, and to ensure that these policies are followed by all members of the corporate team. They enable the clarification of roles throughout the corporate hierarchy, help ensure that the front line of the labor force does not stray from the company's stated policies and plans, and provide a means by which the members of the various workplaces can strive autonomously to meet their goals.

This type of autonomous activity includes job reforms and proposals for new methodologies based on the principles of QC. Since most of these will be tied directly to the policies and plans of top management, they will be used to help revitalize the workplace. The autonomous QC activities conducted by those on the front line are carried out by the most fundamental of the QC groups — the QC circle. In short, TQC contains within it the concept of QC circle activities. We cannot stress too strongly, however, that QC circle activity alone is not TQC. (This logic is neatly summarized in Figure 7.1 which depicts the roles of the various members of the work force.)

The QC circle can be summarized as follows:

In one workplace,
quality control activities
are conducted autonomously
at the small group level.

These small groups, then, are conducted

as one part of companywide quality control activities,
with self-awareness and mutual awareness,
utilizing the QC methodology,
for the control and reform of the workplace
continuously,
by all members of the work force.

Note: QC circle activities are one form of small group activity. It is worth saying a word here about how they differ from other small group activities, such as the Zero Defect (ZD) movement.

Conventionally in small group activity, "motivation" has been one of its primary functions, the stress being on the generation of reform proposals from the bottom levels of the work force, rather than on special techniques or methodology.

The activities of the QC circle, on the other hand, as should be clear from the discussion and definition just offered, are but one part of a companywide QC program and use statistical methodology to promote control and reforms. These activities superficially might resemble other small group activities, but closer examination will show that they are basically different.

Today, a variety of disciplines (such as industrial engineering [IE], value engineering [VE] techniques, and statistical methodology) are being promoted by small group activities. The concept of target-based controls is also becoming more widespread, so QC circle activities themselves may not appear to differ that much from other activities conducted by small groups. It remains true, however, that the essence of the QC circle is that it is but one part of a larger program, one that encompasses everyone in the company. It is important for us to understand that QC circles alone do not make a TQC program.

One view of QC. The QC circle is a uniquely Japanese form of organization that sprang up about 1960 from the exhortations of Dr. Kaoru Ishikawa, president of Musashi Kogyo University and a professor emeritus at Tokyo University. Its purpose would be to promote QC activities on the shop floor in the manufacturing industries. At bottom, then, the QC circle is fashioned from the ethnic identity of the Japanese people and by the familial type of management found in Japan. We can say, furthermore, that it was given life by the desire of the Japanese people to pull together to restore the nation's economy after its defeat in World War II.

The QC circles became a base from which TQC principles became even more widespread than before. From them, the Japanese-style quality control practices were able to become entrenched and led to the development in this realm that can be witnessed today. By "Japanese-style quality control practices," it should be obvious that we are adding QC circle activities to the basic TQC ideal in an organic linking of the two. (The classic reference book in English on Japanese-style TQC is Dr. Ishikawa's *What Is Total Quality Control?*)

I have said that the QC circle is one of the characteristics of Japanese-style quality control. A recent book, *Sketches of America* by Ryotaro Shiba, presents some interesting views of quality control. I shall quote it here because it clarifies the term "Japanese-style":

> *Quality:* For a long time, this was one of the main characteristics of North American civilization. As a philosophy and a methodology, quality control was established in the United States following World War II . . .
>
> Later, in the industrial society of Japan, the principles of QC came to extend to circles at the very tip of the workplace, and came to be one of the basic characteristics of Japanese industry . . .
>
> As far as quality control is concerned in the United States, it has developed as one would expect from a country devoted to the idea of "civilization" (or demonstrating a strong preference for that which is common to all) . . . In Japan, however, it was as though there was a hereditary

system to apply and adapt it to the native culture . . . making quality control a part of the nation's own "culture."

In short, the author holds that while quality control developed in a setting that emphasizes "civilization" (that which is *common*), in Japan it was made a firm part of the indigenous "culture" (that which is *particular*). It is my understanding that one definition of these two terms says that civilization is flow and culture is stock. This being the case, it is certainly true that the QC circle has become a part of Japanese knowledge — it is part of our stock.

Still, one cannot say that TQC will exist where QC circles exist, or that all one needs for Japanese-style quality control is the QC circle. We must never forget that the QC circle exists as one part of the overall TQC program. At the same time, of course, we should also keep in mind two things: (1) that for Japanese TQC programs to be effective, the people on the front lines must participate, and (2) that there can be no TQCactivities without the activities of the QC circle.

The Characteristics of QC Circles in Accounting Departments. Insofar as QC circle activity is but one part of the overall TQC program, it will also be true that QC circle activity within the accounting department will itself be but one part of the companywide QC program. In fact, QC circle activity, by definition, will always be this way, regardless of the division or department where it is carried out. On the other hand, TQC, with its origins in the manufacturing fields, and QC circles, with their origins in manufacturing, are not necessarily the best models for accounting department QC circles. Clearly, there are significant differences between manufacturing and accounting.

Let us discuss some of the most important of these differences. Because simply listing the characteristics of the two, one after another, would be difficult to follow, I have prepared a table that contrasts manufacturing and sales departments. (See Table 9.1.) This is a general model that cannot incorporate the different characteristics among particular companies. I am sure readers will be able to compensate in their own minds for fundamental differences between this table and the realities of their own situations.

A few footnotes should be added to Table 9.1. The headings "topics" and "standardization" contain some particularly critical problems that I will deal with in the following section. Here I would like to add some thoughts concerning the headings "members" and "meetings."

Table 9.1 Comparison of QC Circle Models

Item \ Field	Manufacturing Departments	Sales Departments (primarily front-line sales)
Members	About 10 persons ranked group leader and below. 2-3 circles can be formed from each group with similar jobs in large plants.	About 5-10 persons ranked sales section chief and lower. Chief should have rank of section or subsection head; responsibilities and authority both greater than that of group leader. Jobs include mixtures of sales, service, administrative.
Meetings	Preferably weekly.	Evenings and mornings are often difficult to manage. Thus, group discussion and individual discussions should both be stressed.
Topics	Defect policies, cost reductions, and other close-to-home matters.	Same types as manufacturing departments.
		Strategic, innovative, and positive topics, such as how to increase market share or increase sales price while keeping market share.
	Targets that can be met in short time periods (normally 3 months).	Same as with the manufacturing departments.
		6-month or year plans frequent. In such cases, it is best to set 3- to 6-month interim targets and plan activities around these.
	Only things within one's own range. Stay out of others' responsibilities.	Same as manufacturing departments.
		Frequently involve cooperation with other departments, outlets, cooperating plants, etc. Adjustments are critical.
Standardization	Matters easily made into work standards.	It is difficult with many jobs in these areas to institute 100 percent standardization.

Note: The principle of avoiding other departments' areas of responsibility does not apply to the accounting department, which must make others' responsibilities its own. It must be acknowledged that reforms and standardizations made by the accounting department will apply to the entire company.

Accounting Departments (Administered by Subsection Leader or Below)	**Administrative Precautions**
In small and mid-size firms, 5 or fewer persons ranked from section chief down (usually 2-3 persons). Mostly female clerical employees.	Many points among the responsibilities of sales directors and accounting subsection chiefs are not found in the responsibilities held by foremen and group leaders on the shop floor.
Meetings can be held easily, but it should be understood that there is no forced overtime as a result.	The QC circle should study what is happening at the work site. It should perform surveys in addition to administering tests and other more theoretical studies.
General topics close to home.	(a) Select topics that will hold the interest of female employees. (b) Devise topics that will support top management's front- line policies and can be implemented. (c) Circle leaders should get together to make adjustments to reform proposals so that they can be implemented by all departments involved. This makes it necessary to acknowledge the authority of the circles.
Take lead to ensure that positive, sophisticated topics are also selected.	
Same as manufacturing departments.	
Same as sales departments.	
Same as manufacturing departments.	
In some cases, the accounting department will take the lead for other departments (see note).	
Do more than change regulations or forms. It is important to standardize daily jobs.	The authority of accounting job manuals and procedures should be recognized by other departments and considered by upper level management.

The composition of membership and meetings. This is not limited specifically to accounting departments. There are cases in which the number of members of a QC circle in the administrative fields is small, and people of the rank of department chief or subsection chief have in reality been added to the circle. The difficulty in such cases is the danger that the activities of the circle can then be linked directly with, or confused with, normal business or job activities. This renders it necessary for supervisory personnel to distinguish clearly in their minds the differences between (1) control activities that have as their goal the implementation of directives from the plans formulated by top management to improve the way management is conducted, and (2) the activities of the QC circles. The autonomy of the QC circle must be respected at all times.

Furthermore, in cases where the number of persons making up a QC circle is small, and the scope of their duties is broad, lower level management personnel may sometimes need: (1) to have a thorough understanding of the characteristics of TQC programs and the essence of the QC circle, (2) to begin with meetings that are similar to bull sessions for people in the workplace, and (3) to employ QC methodology in the selection of topics and reforms that are to be addressed, so that the groups involved can ultimately evolve into autonomous QC circles. When this is done, however, great care must be taken to ensure that the bull session rises above the level of aimless chatter and takes on a focus.

Shop floor study and experience. In accounting departments, the majority of daily duties are performed behind a desk. The people assigned these duties, more often than not, are removed from happenings on the manufacturing shop floor, and in the sales offices, and from environments where the products are actually used. QC circle activity provides a valuable opportunity for these personnel to visit other locations and receive hands-on training. Not only do they thereby deepen their understanding of other fields, they have a chance to exchange opinions with people in related areas. Plans should be made in advance for this type of practical work. Departments could decide to conduct such activities every other month, depending on how the QC circle is handling a certain topic. They should be scheduled regularly, however.

An example that comes to mind is that of a QC circle composed of tracers in a design department that made monthly study visits either to the manufacturing facility or to locations where the products they made were used. Their experiences led to a number of improvement suggestions regarding both design and manufacturing. Accounting departments should engage in similar activities.

QC Circle Topics for Accounting Departments. Most of the general topics dealt with by QC circles involve policies regarding defects, mistake-proofing practices, and ways to reduce costs. Given the historical context of the quality control movement, it is only natural that topics such as these should be predominant. Table 9.2 shows a breakdown of such topics by specific items covered.

Table 9.3 gives some examples of topics chosen by different departments in the support sectors.

The following are topics frequently chosen by accounting departments:

- reducing the number of invoices and other slips
- conserving office expenses
- simplifying the process for making cost estimates
- simplifying office duties by arranging for automatic bank deposits of salary payments
- shortening the time required for calculations
- simplifying procedures for dealing with cash transactions
- eliminating calculation errors
- reforming procedures used in the storage of spreadsheets

The following examples, as opposed to the previous ones, are topics that deal with expanding rather than reducing an element of the system:

- increasing interest payments by changing the types of bank accounts held by the company
- devising a method to simulate profit-and-loss fluctuations brought on by changes in the production process or sales figures

We have been stressing two things, particularly in Part II: that (1) accounting is the foundation of management control, and that (2) the use of computers in accounting is increasing dramatically. Given this trend, it is only natural that the focus of QC circle activity should move beyond the simple rationalization and efficiency-increasing topics of the past to encompass a broader and deeper range

Table 9.2 General Topics of QC Circles

Item	Examples of Topics	Remarks
Quality	• Reducing defects, reducing deviations, eliminating claims • Eliminating inspection errors (reduction) • Improving precision	Depending on circumstances, this could take the form of either increasing precision or reducing the number of pieces that do not conform to targeted precision level.
Efficiency	• Eliminating late deliveries, quickening deliveries, simplifying procedures, streamlining • Reforming transport methods • Shortening job times	Shortening administrative time, reducing paperwork, and simplifying procedures are among the topics addressed.
Design	• Shortening hours lost due to failures • Developing better fixtures and tools • Promoting automation • Changing equipment layout	
Costs	• Lowering expenses • Cutting unit costs • Conserving materials • Reducing worker hours	
Safety, Environment	• Order and orderliness • Preventing fires • Preventing fatigue	Order and orderliness must be approached as a problem of shortening the amount of time lost searching for things, and targets must be put into a form that can be measured by the use of data.

Table 9.3 Examples of Topics Chosen by Administrative and Support Divisions

Department	Example Topics	Remarks
General Affairs	• Simplifying receptionist duties • Speeding up telephone operator's job • Conserving telephone expenses	
Custodial	• Ashtray cleaning • Reforms in periodic inspection of fire extinguishers • Reforms in corridor and foot traffic control • Reforms in duties of general reception	
Personnel	• Implementing training programs • Evaluating training materials and results • Implementing QC training plans	For safety and sanitation, see Table 9.2 under "Safety, Environment."
Warehouse, Transportation	• Inventory reduction • Reforms in layout of stored materials • Reducing packing expenses through packing reforms • Reforms in inventory-taking jobs • Reforms in transporting jobs	
Materials, Purchasing	• Eliminating ordering errors • Use of unnecessary, noncritical materials • Optimizing inventory amounts and reducing ordering costs	
Testing, Inspection	• Reducing time needed for inspections • Eliminating inspection errors • Simplifying inspection records • Increasing accuracy of measuring instruments and test efficiency	
Office Equipment	• Reducing hole-punching errors • Increasing operating efficiency of calculators • Increasing cooperation with materials department	
Design	• Reducing design changes • Increasing cooperative use of parts storage areas • Increasing efficiency of blueprint creation • Increasing design efficiency	

of concerns. Considered from this perspective, small group activities might be said to transcend those of the QC circle and move closer to the work one might expect from a research or study group. For example, the following topics cover a considerably greater breadth and depth in management terms than those previously listed:

- creating (or reforming) formulas used to determine changes in product sales prices and sales levels, and to measure earnings fluctuations brought about by changes in interest rates
- using computers to prepare unified calculations of all materials handling costs in manufacturing, inventory, and sales, and implementing policies designed to lower these costs

Examples of sales department topics. It seems natural that topics handled by accounting department QC circles should be shifting in outlook from static to active, and from administrative to strategic. In much the same way, there is no doubt that strategic and technical topics that are now the focus of sales department QC circles, such as how to deal with defects, are also of great interest to the accounting department. These topics are summarized in Table 9.4.

When we consider that (1) the strengths of marketing lie in sales activities, and that (2) it is the job of the accounting department to lay the foundation for these activities, the fact that the topics considered by sales department QC circles are related closely to those of the accounting department should be even more apparent. They cannot be ignored simply because they are perceived to be the business of some other department. There are so many items of mutual concern to both sales and accounting departments that the best approach is one of cooperation.

Because the accounting department is the base for all other departments, it is important that it heed the preferences and desires of the other departments in selecting topics for QC circle attention. This is the same logic that says that the sales department should pay close attention to the voices of its customers when deciding which product lines to expand and what types of new products to develop. It is a manifestation of the "market-in" approach. Using this approach, the accounting department — traditionally considered a static rather than active department — has breathed new life into the corporation as a whole, yielding a host of unexpected benefits.

Table 9.4 Examples of Sales Department Topics

Department	Example Topics	For Retail Outlets
Sales	• Increasing planning accuracy by comparing plans with sales results • Increasing number of visitations (see note) • Increasing competitive rate (see note) • Increasing sales prices • Increasing efficiency of sales talks • Increasing number of firm orders	• Improving attitudes in dealing with customers at the cash register • Widening sales of important products • Implementing customer control measures Note: Target is increased market share
Service	• Increasing number of calls made • Increasing service sales • Reducing rate of return service calls to zero • Increasing inventory efficiency of parts • Lowering number of claims • Releasing news concerning ways products are used	• Reforming inventory-taking procedures • Increasing order and orderliness of warehouse • Reducing costs in making orders
Business Management	• Decreasing losses due to defects • Eliminating the generation of losses due to defects • Reducing management costs • Implementing policies to ensure that catalogs are always in stock • Increasing rate at which products move through warehouse	• Reforming advertising campaigns • Taking measures against shoplifters • Taking measures to prevent sellouts of popular products

Points of special interest regarding topics handled by accounting department QC circles. Several points in the selection of topics for accounting department QC circles, and in the operation of these circles, require special attention.

I have stated repeatedly that the definition and scope of the accounting department's duties have been fixed to a considerable extent by both tradition and the legal system. Most of its duties are administrative, and in many cases topics regarding the rationalization and streamlining of the department are considerably more limited than is the case with other departments. Furthermore, by its nature, this administrative aspect of the department's duties is linked to the jobs performed by other departments and other accounting duties; in many cases, it is not possible to limit a topic to one's own job alone. In other words, regardless of how broad the specific duties of an individual accounting job might be, compared to other jobs, its scope is narrow. In addition, the reforms carried out tend to concern matters of procedure rather than substance, and are more pedestrian than, for example, the purchasing department's use of value analysis. If we take this argument a step further, however, the central position that accounting department topics occupy in a number of related jobs testifies to their importance. Supervisors and monitors should thoroughly understand these facts and their relationships to the whole, ensuring circle members autonomy both in their selection of topics and in their operations.

The tendency of the reform operations to be administrative means that great care must be given to the use of computers in these operations. As already noted, accounting skills evolved from proficiency on the abacus, and technical knowledge of ledgers accompanied by beautiful penmanship were matters of great pride. The computer has made fundamental changes in the nature of accounting department activities. The reforms implemented during the process of such changes often include points that are more than simple matters of rationalization. For example, the accuracy of checks prior to inputting can be more important than the speed at which calculations are made. In such cases, the question of how to wed the skills of people trained under the old system to the job of checking figures involves more than simple job reforms — it requires careful consideration.

In this regard, the duties of the accounting department are shifting from the mere act of performing calculations to participation in the formulation of business plans and asset analyses, and in increasing the efficiency of calculation processes. As this occurs, the topics dealt with by accounting department QC circles can no longer be simple matters of administrative operations. They will evolve naturally into research regarding the nature of the new, broader duties just discussed. While this is reflected in the sample topics listed, it is up to managers and supervisory personnel to create the positive environment that will encourage the study of such topics.

One way to begin the process of selecting QC circle topics is to refer to topics selected in the past by other companies. A point of caution: When doing this, be sure that the accounting units used by the different companies are compatible. While this may seem obvious to members of accounting departments, two firms the same size and in the same line of business may deal with accounting units differently. Some examples:

> *Method 1.* Accounting units may treat the entire company as a whole (unifying the head office, sales locations, and plants).
>
> *Method 2.* While treating the entire company as a whole, accounting units may have the head office, sales locations, and plants perform their calculations individually and send them to the head office for unification.
>
> *Method 3.* Accounting units may treat the head office, sales locations, and plants individually and have them perform their accounting functions separately.

Differences in accounting units or in the methods used to total figures can give rise to differences in the way reform topics are approached and carried out. For example, companies using Method 1 will stress jobs that bear on the accuracy and speed of information received from retail outlets, plants, and the like. Those using Method 3 might stress measures that simplify the accounting interactions between various arms of the company when preparing joint statements. Supervisors must give these factors serious consideration when devising the QC circlesystem.

The length of time allocated to individual topics. It can be surprisingly difficult to determine the proper length of time that should be spent by a QC circle on activities surrounding one topic. Some topics are similar to those in manufacturing (such as reducing mistakes in copying figures) and can be handled adequately in two weeks or a month. However, while you can schedule planning periods for three to six months, in most cases, clear results cannot be obtained from accounting department projects (such as reducing losses due to defects, increasing actual sales price, and applying economic calculations to equipment investments) in that length of time. Even so, it is hardly desirable to wait around for results for six months or more. It may be preferable to set a planning time frame of one year and establish within it targets of three months, six months, and so on. The first three months can be considered a preparatory stage in which the basis for reform is established. Other periods can then be planned in terms of the types of results expected from reforms. This type of planning is very important.

Table 9.5 is an example of a reform plan. It was prepared with reference to a plan developed to reduce the number of defects that cause losses due to contractual obligations.

Results and standardization of QC circle activities. Establishing reform policies based on the results of QC circle activities can prevent the recurrence of defects and improve efficiency levels within the department. To ensure that these results are permanent, make them a standard part of job procedures. Be aware, however of two problems that often surface at this stage.

The nature of jobs in the accounting department and the various departmental regulations are more precise than those in other departments. Thus, any sort of reform proposal is apt to provoke such responses as: (1) problems would not exist if jobs were performed according to the standards in the first place, or (2) rules would be more effective if they were interpreted according to the reality of daily activities. When this happens, there is a tendency for someone to note in the minutes of the next departmental meeting that the reform proposal offers a certain interpretation of the regulation already in place and it should be implemented properly. This leads to the fear that the proposal will never make it into the job procedures manual or become a new standard. This is not the true spirit of QC. The task of the QC circle is not completed until the circle returns to point zero and (1) determines why the problem arose in the first place, (2) decides what can be done to prevent it from recurring, and (3) standardizes the solution so that it can become a platform from which to raise the overall level of the department. (Depending on the nature of the problem, the solution might be to make a new regulation or establish a new job procedure for the department.)

I have just implied that standardization can be attained by turning the proposal into a regulation or making it a part of job procedures. In reality, however, there are other ways to standardize. Because there already are so many legal restrictions and regulations, particularly in the world of accounting, "standardization" does not have to imply the necessity of creating ones. In many cases, it is more appropriate to standardize by revising the job procedures manual or switching required textbooks, thereby keeping procedures as up to date as possible. This approach can utilize the results obtained through QC circle activities. In such cases, don't forget to assign a person to be responsible for periodically reviewing and evaluating the changes. (See Chapter 6 for more information on this topic.)

Encouraging Reforms Based on QC Circle Activities. A Japanese book that I have already mentioned, *The Fundamentals of Operating a QC Circle*, contains a detailed discussion of how to administer a QC circle. Here I will present the highlights only. And while it may seem tedious, it is critical that anyone administering a QC circle thoroughly understand the material contained in Part I of this book (concerning the relationship between the fundamentals of TQC and the QC circle), in Part II (concerning the position of QC), and the main characteristics of the QC circle in the accounting department as discussed in the previous section.

QC circle meetings. The following is a list of items to be covered when convening the first QC circle:

1. *Preparation.* Write everything down on large sheets of paper — even when, during the course of discussion, things might be reevaluated or seem unimportant. If written down, they will be available later.
   - large sheets of paper, erasable blackboards
   - three or four colors of magic markers
2. *Selection of leaders.* Select a group leader and a recording secretary.
3. *Explanation of purpose.* The section chief must explain to everyone's satisfaction the overall situation, the policies

Table 9.5 An Example of a Reform Plan

Plan for Reducing the Defect Generation Rate

Item / Implemented	Responsibility	Projections 61/1	2	3		11	61/12	Remarks
I. Survey	Sales offices A and B	1 2	3					
II. Compilation of Job Manual and Instructions	A, C	1	2	3				3/20: Heads of sales offices have meeting
III. Use of Computers in Planning	B, D		1	2				3/21: Instructions circulated through all sales offices
IV. Execution of Reform Plans	Individual sales offices	1		2	3	7	8	November: Outstanding sales office recognized at QC meeting
Defect Rate		5%	3.7%	3.0%		1.5%		

Implementation:

I. (1) Creation of survey procedures
(2) Survey
(3) Survey results compiled

II. (1) Current manuals inspected
(2) Manuals revised to conform to survey results
(3) Manuals provided for instructions

III. (1) Related programs surveyed
(2) New program created (with manuals)

IV. (1) Interim policies formed
(2) Interim policies implemented
(3)-(7) New manual implemented
(8) Manual reevaluated and revised

Reform Targets (to reduce defects from 5% to 1.5%)

End of February	- 3.7%	- To lower rate by implementing interim policies that eliminate mistakes caused by overlooking problems
End of March	- 3.0%	
End of June	- 2.7%	- Full implementation of item I
End of September	- 2.0%	- Use computer to speed up checks and discover errors before they occur
End of November	- 1.5%	- All items implemented through item III

received from top management, and the direction it is hoped that reforms will take. (Following this introductory explanation, things should be left to the autonomous progress of the group).

4. *Summation of problems.* Pass out paper to every member of the group present. Ask them to write down, as simply as possible, three to five problems, proposed reforms, and their reasons for selecting them. Using these suggestions, the group leader prepares a summary list of problems that is recorded by the group's secretary in front of those present.

   Note: Do not use ambiguous language in preparing this list — clarify everything. In cases where the problem as well as the opinion and countermeasures are vague, trace the problem back to its roots and present it clearly and simply.

5. *Have everyone say a few words.* Although some people present may find it difficult to address the group, the leader should skillfully urge even the least articulate member to comment.

Procedures in the Promotion of Job Reforms. At this point, the textbook approach is for the group leader to chart the procedures involved in instituting QC circle-related job reforms.

(See Figure 9.1.)

Examples of statistical methodology used in these procedures have been taken from the most simple of the so-called seven QC tools. It is my impression that recent QC circle work has been gradually increasing in level of sophistication. I present this material in the hope that readers will reevaluate the basics, and use the methods properly.

Topics that Require Caution in Handling: Some Examples. A typical example of a topic taken up by accounting department QC circles is "lowering operating costs." This issue is of fundamental importance for any department in the corporation. Often, other departments grappling with this problem have come to the accounting department for current information concerning actual performance. I have seen cases, however, where the department dealing with this issue is

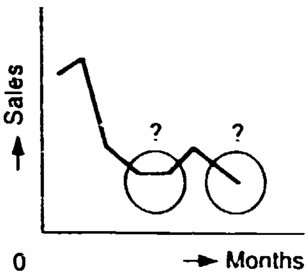
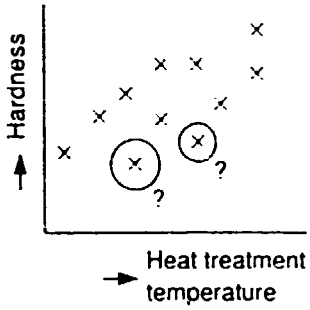
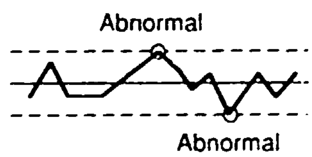
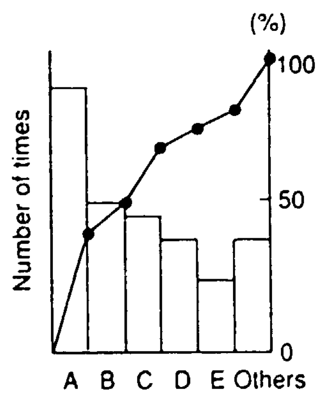
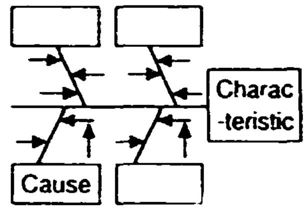
Step	Procedures	Examples of Methodology
1	**Discover Problems:** 1. Use existing data to come to a thorough understanding of the present situation. a. What are the tendencies? b. What are the interrelationships? c. What are the deviations? 2. Plot market trends and distribution of customers on a map. It is important to express the data clearly. 3. Get concrete examples of exactly what the problem points are and where they lie.	 **Graph**
2	**Determine Topics:** 1. Classify, centralize, and place problem points in order. 2. Which problems are important, and which would be more effectively dealt with first? Which problems are faced by everyone? Discuss these issues in the group, and select topics. 3. There will be many problems for which data isinadequate, so it is acceptable to classify the problems and determine topics on the basis of an exchange of opinions at this point. 4. Reconsider topics too big or too small to handle efficiently. Note: When determining topics, it is good to consider them in terms of how they fit with the policies sent down from top management.	 **Distribution Chart**  **Control Chart**
3	**Clarify Topics and Set Targets:** 1. Study the topics in terms of concrete, objective facts. To do this, it will be necessary to reexamine graphs and records and restate the topics. 2. Determine the specific targets from the real-world relationships that have been established (the characteristics from a cause-and-effect diagram). Note: Real-world relationships are complex, and when determining targets (characteristics), it may not be possible to make the determination easily. If this is the case, debate the issues, and determine two or three points that most people feel are important. Be careful not to simply bow to the majority and take too broad a view of something that has been broken down more carefully.	 **Pareto Diagram**

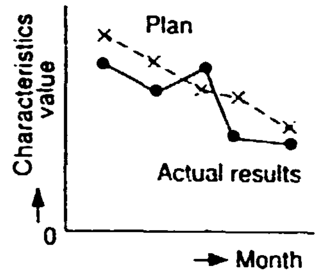
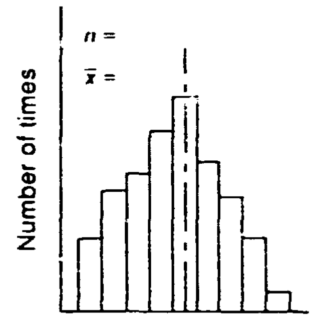
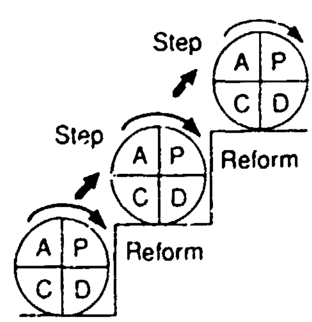
Figure 9.1 Procedures in Establishing Job Reforms

<table>
<tr><th>Step</th><th>Procedures</th><th>Examples of Methodology</th></tr>
<tr><td>4</td><td>Determine Causes and Discover True Cause
Search for the cause (reason) whose reality (characteristic) has given rise to each target (characteristic) selected, and uncover the true cause of the problem.
Notes:
1. Do not confuse symptoms with real problems.
2. Continually ask Why? as you search for causes until countermeasures have been put into effect.
3. Clarify standards in debate, avoiding words such as "good," "bad," "many," and "not many."
4. Avoid expressions such as "inadequate connections." Ask questions such as Which subsections? or At what point in time?, or What type of communication? when searching for causes.</td><td>

Cause-and-Effect Diagram

Note: It is easier to keep things straight if the 4M's are entered in the causes column.</td></tr>
<tr><td>5</td><td>Plan Countermeasures:
1. Use methods such as "5W1H" or the "Osburn Method."
2. Reevaluate realities and the workplace itself.
3. Distinguish between interim solutions and long-term (fundamental) solutions.
4. Countermeasures should avoid precautions or philosophical arguments.

The 5W1H Method & the Osburn Self-Questioning Method: →</td><td>WHY What would happen if you stopped?
WHAT What would happen if you opposed?
WHERE What would happen if it were larger?
WHO What would happen if it were smaller?
WHEN What would happen if you changed the order?
HOW These and other questions are asked when following up a problem.</td></tr>
<tr><td>6</td><td>Determine Plan of Execution and Implement It
1. Establish concrete targets for reform.
2. Determine stages within the long-term (fundamental) countermeasure and set interim goals.
3. Decide on the methodology to be used in implementing the plan and set it out clearly in a procedures manual.
4. Clarify plan of execution and decide on an execution schedule for the important items.
5. Train people in the methodology.
6. Execute plan according to the methodology selected and gather data during the course of this execution.</td><td>Graphs
Distribution Charts
Control Charts
<table>
<tr><th>Date / Position</th><th>3/1</th><th>2</th><th>3</th></tr>
<tr><td>A</td><td>/</td><td>/</td><td>//</td></tr>
<tr><td>B</td><td></td><td>//</td><td></td></tr>
<tr><td>C</td><td>////</td><td>////</td><td>///</td></tr>
<tr><td>D</td><td>//</td><td>//</td><td>///</td></tr>
<tr><td>E</td><td>//</td><td></td><td>/</td></tr>
</table>Defect Checksheet by Position</td></tr>
</table>

Step	Procedures	Examples of Methodology
7	**Confirm Results** This involves more than simply studying the results. Use the results to give careful consideration to the method of making the plan, methodology, method of training, and other processes.	 Graph  Histogram
8	**Determine ways to make the reform proposal a part of the job.** 1. If the reform proposal implemented works well, make it a part of the daily job (standardize it) by writing it into regulations, standards, job manuals, training texts, etc. 2. Clarify the interval at which the regulations and job manuals will be reevaluated and who will be responsible.	
9	**Remaining Problems and Subsequent Plans** 1. If reform proposals are not sufficient, take remaining problems back to step 1 and start over. 2. If reform proposals are sufficient, standardize them and do the following: a. Move on to the next problem b. Move to a higher level (true reforms)	 Reform = Step = Control

not successful. In the following examples, I will note some precautions that should be taken when dealing with such a topic.

Case 1: Lowering telephone bills. As part of an overall effort to lower operating expenses, a certain sales office decided to launch a QC circle project to reduce by 20 percent its monthly telephone bills of ¥1 million (U.S. $7,000). Without considering any other issues involved, the project got underway enthusiastically and snappy slogans encouraging telephone conservation were pasted onto telephones.

However, one thing they should have considered at this stage was the purpose of the sales office. In other words, its purpose was sales — efforts that would result in increased sales and a higher market share for the company. Achieving this purpose would entail an increase in the number of telephone calls made by sales personnel, as well as an increase in meaningful dialogue with the powerful people in client companies. This being the case, it would be important to (1) make appointments with clients before making visits, and (2) discuss sales materials with them prior to seeing them. This would increase both the effectiveness of the visits and the number of visits the sales personnel could make. If this is why telephone usage is increasing, little can be done about it. In fact, this is a case where management should inform the sales staff that there is nothing wrong with rising telephone bills — that it is more important to keep in close touch with clients and cut back on the number of unnecessary visits.

Of course, certain telephone calls should be eliminated. For example, personal calls, needless chatter, and calls that simply recap what has already been transmitted by fax to a client should be restricted. This means that the topic taken up by the QC circle should not be just to reduce telephone bills. Instead, a topic should be meshed carefully with more important matters. It is important for all departments, including accounting, to understand the main points behind any drive to lower expenses.

Case 2: Conserving receipts. This example actually happened to me at a large department store adjacent to the main railroad station in a large urban area. I had purchased a box of candy for several thousand yen and did not get the regular receipt along with my change. When I asked about the receipt, in turn, I was asked, "Do you need a receipt?"

When I replied that I did, the register clerk responded, "One moment please. I'll have one written out for you."

The register clerk then left the cash register, went to the candy department, asked a clerk for a receipt, and finally returned to the register, apologizing for keeping me waiting. When I asked, "Don't you give receipts?" the clerk replied, "We only give them to customers who request them." The clerk's attitude was pleasant and it was apparent that this was a policy of the store.

It is easy for a store to assume that few customers actually need a receipt or a bill of sale. But if you think that this is all a receipt signifies, consider the following points:

1. Do customers require receipts for any other reasons than official, such as for taxes or business expenses? Or, even if they want them, will they ask individually for receipts for things they have bought for several thousand or several hundred yen? Does the fact that they have not asked for a receipt mean that customers are satisfied at not getting one? Virtually every store in existence today employs a cashier at a register, and it is natural for this person to hand over a receipt. Therefore, when a customer doesn't receive one, will he or she feel good about it? We often speak of the "spirit of service," but what do we actually mean by "service"? Are receipts and service totally unrelated in this sense?
2. Since it is almost inconceivable to consider a store without a cash register, let's assume that the store has one. Now consider the difference in price between registers that give receipts and those that don't. We were talking of a large department store, and in terms of its overall equipment investment, this difference could mean a good deal of money, in addition to the cost of the receipts themselves. But even so, what in the world is this store doing to classify sales, monitor inventory, study costs, and the like? Does its accounting department think that everything is fine if the numbers come out right?

What would the department store in question think about this example? Doubtless this does not relate to quality control. If the store were truly pursuing TQC, I think it would be concerned with the "spirit of service," and would consider factors such as operating expenses and efficiency from different perspectives. The reason I bring up this example is to stress the idea that QC topics for accounting departments and accounting-related fields face the dangers of falling into trivial activities if QC circle members keep their blinders on when considering topics such as lowering operating expenses.

Case 3: Conserving place mats. This example also comes from a well-known department store in a large urban area. This time it is from a restaurant operating out of the department store's "restaurant row." This is a popular restaurant that specializes in Japanese-style food, and the pictures on its paper place mats are quite beautiful. In this case, the problem is that the restaurant was reusing these mats even though they were dirty and wrinkled. I don't know how often the mats were being reused, but judging from the number of wrinkled mats I saw, I suspect that it was more than twice. Also, it was clearly visible to customers that used mats were not thrown away, but were stacked on shelves for reuse.

I grant that this is one way to practice the art of conservation, but somehow it does not seem appropriate for a restaurant in a famous department store — one where the food itself is both spotless and beautifully arranged.

In any event, it would seem to me that taste, beauty, and reputation should be valued more highly than conservation in this instance. At the very least, if the restaurant is so keen on conservation, it should switch from the paper mats and their beauty to mats made of more durable materials. I have no desire to be served on a place mat that is wrinkled or soiled with the remains of another customer's meal.

While I don't believe that this store was engaged in TQC activities, I present it as an example of the types of problems that can occur when TQC is too wrapped up in the idea of savings.

The previous examples were of cases where saving operating costs were topics for QC circle activities. A number of additional examples could be noted of topics unlikely to succeed. These are the types of pitfalls awaiting people who feel that TQC does nothing more than consider short-term savings or process as many employee suggestions as possible, without taking into account the true meaning of the jobs that must be performed. If QC circle activities are allowed to continue at this pace, in no time at all the TQC program itself will grind to a complete halt. Care must be taken to avoid this.

The underlying idea behind TQC is to improve the essence of the product or job. Keep this idea continually in mind when planning QC circle activities.

Measurement and Control in Continuous Process Industries

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I. Process Control: Basic Principles and Approaches

1. The Basic Principles of Control

When thinking about process control, it is necessary to reflect anew on the subject of work site control.
Initiating work site control, in turn, requires an understanding of the basic principles, namely, "What is a work site?" "What is control?" and "What is work site control?"
In any activity, failure to implement that activity without proper understanding of the basics can lead to omissions and improper direction in the activity. In short, control of a modernized work site is not possible unless the basics of control are properly understood; unless past knowledge and experience are used to create new intelligence; and unless control is suited to the specific workplace in question.

1-1 What Is Work Site Control?

To control a work site, it is first important to initiate activity with an understanding of the original objectives of work sites, and with an awareness of what kind of control is necessary. This also applies to processes where either computers or automated equipment are used in production.

1) The Purpose of the Work Site

Let us consider what a work site is and what its objectives are by looking at manufacturing processes.
A manufacturing process can be defined as "a process whereby the necessary product is created by assembling or otherwise processing parts and materials with human workers or machines and using a certain work method, etc."
However, upon careful consideration, one can see that in manufacturing, it is not the manner of work itself (e.g., assembly or processing) that is necessary; rather, the crucial function of manufacturing (that is, the work site) is to use work as a means of achieving the required qualities of performance and functions in the form of products.
According to this definition, the objectives of a work site can be broadly summarized as the following.

Creating products with the specified quality (Q = Quality)
The quality required of the products to create is specified by the design division as, for instance, product standards and manufacturing process standards. After properly understanding the required quality, all factors that affect quality, such as human resources, machines, parts, materials and work methods, are unfailingly identified in order to unfalteringly create products with the quality specified.

Keeping the product's manufacturing cost down (C = Cost)
Another objective is to minimize the cost of all materials, labor and expenses required to produce the product, which is done by reducing unreasonableness, waste and inconsistency through an effective combination of such steps as preventing defects in and the loss of materials, reducing waiting time, and eliminating the wasteful use of office supplies and consumable tools. Particularly in the case of automated, mechanized or computerized processes, increasing utilization rates to assure proper quality is also a part of process control.

Making the specified quality of a product by the delivery date (D = Delivery)
It is also important that products of good quality be made in order to meet the predetermined delivery date. This means controlling the progress of production according to production plans, process plans and job instruction sheets, for instance, so that the product is made and delivered by its delivery date. Another important objective is bolstering control in order to boost productivity.
These aspects of production must be controlled unfalteringly no matter how modernized production is, and can even be said to be the starting point of control.

2) The Control of Work Sites

Work site control involves controlling the human resources, parts, materials, equipment, work methods and other aspects of a location that represents the conditions under which manufacturing is performed, using the foregoing objectives of the work site (i.e., manufacturing) — namely, a product's quality, cost and quantity/delivery — as the standards for control.
Or, put in other terms, work site control means economically controlling the conditions of manufacturing in order to attain the objective of manufacturing, namely, assuring a product's quality, low cost, quantity and on-time delivery.
Next we shall examine the basic principles that define the essence of controlling.

2. The Basics of Control

2.1 What Is Control?

Control can be defined as verifying that a job is being performed according to specified policies, plans and standards and, if the job deviates from plans, etc., drafting corrective measures and implementing them according to plan so that the job progresses satisfactorily. However, in conventional production, commands to, say, improve quality or lower costs are sometimes merely relayed in tunnel-like fashion from the president to the plant manager, then to section chiefs, group leaders and finally to the workers. Under circumstances such as these, even proper control is not possible unless such commands are followed to the letter.

The basics of control consist of checking and rechecking the following procedure.

1) Defining goals
2) Defining methods } → Plan = Planning
3) Education and training
4) Implementation } → Do = Implementation
5) Checking → Check = Evaluating
6) Taking corrective measures
7) Determining whether actions had the proper effect or not } → Action = Rechecking actions

This circle of planning, doing, checking and action is called the circle of control (Fig. 1).

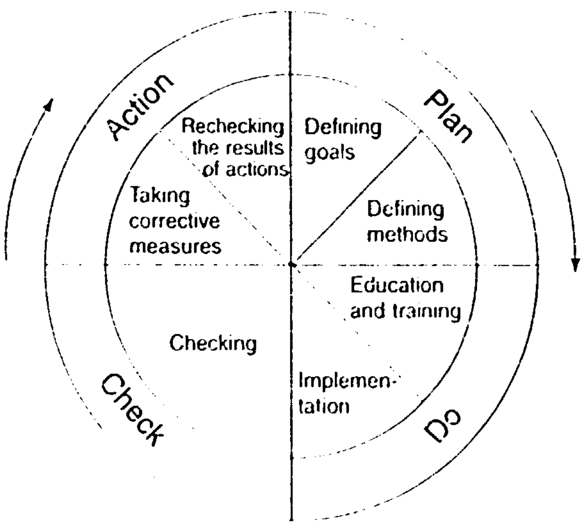


Fig. 1 The circle of control

3. An Approach to Process Control

3.1 The Principles and Procedures of Process Control

Here, process control refers to the control of processes. Controlling the progress of production is known as "progress control," which must be distinguished from process control.

Also, the term "process" refers not only to so called manufacturing processes, but also the methods for many types of jobs; even the flow of slips and other paperwork is a type of process. Thus, although process control is discussed below primarily as it concerns manufacturing processes, it is also important to apply process control to the processes of many other types of jobs.

The Principles of Process Control at Sites

Although process control, as the name implies, is the controlling of processes, it is first necessary to clari_ _ meanings of the following:

1) A process
2) Control
3) The action of control (i.e., going through the circle of control)

A process is a flow of work used to achieve an objective, such as a series of processing or assembly, and can be thought of as a group of causes (such as human resources, machinery, materials and job methods) that effect this objective.
Control means setting a goal or standard (i.e., planning); implementing (i.e., doing); checking whether the desired results are being achieved (i.e., checking)' and, when an abnormality occurs, taking corrective measures to restore things to their proper condition, and encompasses all methods used to achieve the goal or standard in question.
"Going through the circle of control" means repeating the process of planning, doing, checking and action.
Thus, process control also means smoothly going through the circle in Fig. 2.

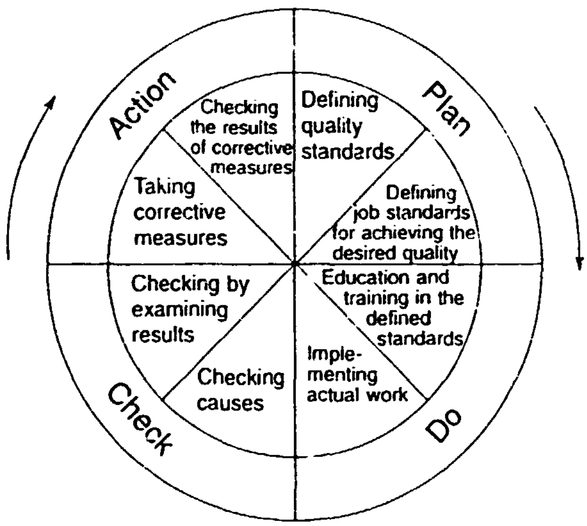


Fig. 2 The circle of control and the procedure of process control

3.2 Control Principles for Achieving Good Quality

It is said that quality is made at the work site, and it is important that products are made precisely according to the design division's quality standards.
To this end, it is necessary to understand what good quality is and what must be done in order to create it.
Looking at product quality from the user's (i.e., the customer's) point of view, actualizing the quality that a product needs to function properly is called quality assurance. What a work site needs regarding quality assurance can be summarized as follows.

3.2.1 Clarifying What Good Quality Is

Good quality can be thought of in terms of the following.

Quality in Use

The foundation of qualit_ assurance is approaching quality from the customer's point of view. Hence, good quality means that, when used, the product functions and performs properly and in the necessary manner. This makes it important to determine what type of quality is needed by thoroughly investigating how the product will be used.
A pencil, for instance, should write smoothly, resist breaking, be easy to sharpen and easy to grip, among other characteristics. These are true quality characteristics, as they embody the quality the consumer desires. In contrast, control at a work site is based on such characteristics as materials, strength and dimensions (i.e., substitute characteristics). However, a system should be established in which control encompasses not just substitute characteristics, but also true quality characteristics as well.

Quality That Takes Price into Account

Quality must always be considered side-by-side with cost. Although consumers who desire products with superior performance will purchase them even if they are somewhat expensive, products that are expensive because of more quality than necessary (i.e., excessive quality) cannot be called good products. A product should have sufficient quality for the purpose for which it is used, and also a price suited to its quality. This is what Japanese quality control has succeeded in.

Quality with Low Variation

There is always variation in product quality, even in the quality of products made by the same workers using the same machinery and methods. For instance, attempting to cut material to a length of 50 mm can result in some pieces that are 50.1 mm long and others that are 49.9 mm long.

Although there is always this kind of variation in the quality of actual manufactured products, the term "good quality" refers to products with low variation. To minimize variation in quality, there must be sufficient control of machinery, methods and other conditions of manufacturing (known as elements of quality) in order to ensure consistency.

Particularly in cases of advanced automation, labor saving and computerization, what appears to be advanced can actually reduce efficiency and increase variation unless there is proper consideration of machinery and methods.

3.2.2 Raising Everyone's Quality Awareness

Products with good quality never occur by coincidence. Nor does good quality result from concentrating on raising output or relying on inspection to assure quality. Instead, workers must be imbued with the principle of emphasizing quality and with a sense of responsibility regarding quality, and their quality awareness — i.e., the realization that processes create quality — must be raised. QC circles, which approach this issue through voluntary action, are also an important issue in the 1980s.

Quality awareness means constantly striving to comply with and meet the predetermined quality standards as well as other standards.

Steps such as the following are needed to raise this kind of quality awareness.

Thoroughly teaching each worker the correct criteria for work

Workers must be constantly aware of whether their work complies with job standards and is correct, and whether the products being made satisfy quality standards.

In short, they must be aware of the fact that quality is made in the manufacturing process.

Quality is not made by testing or inspection; products of good quality are made by workers. And so, education is needed to prevent such erroneous thinking as, "Inspection will catch whatever defective products we make."

Making workers aware of exactly which jobs each of them is responsible for in order to make products of good quality

Workers must be told what the final objective (i.e., quality) of the product is, which job each of them must perform to achieve this objective, and what purpose each job serves.

Inspiring competitiveness and enhancing skills so that no defective products are made

Providing detailed information on any defective products that are made, and working together with the workers to prevent their reoccurrence

An issue for the 1980s is raising quality awareness by actually bringing up a work site's quality-related problems, initiating activities to maintain and improve quality (such as QC circles) and, through such activities, providing guidance on what quality is and how to achieve good quality.

3.2.3 Complying with job standards (job instruction sheets)

In order to create products of good quality, workers must be made to correctly comply with job standards. A job standard defines the methods for performing jobs needed to achieve the desired quality; products of good quality cannot be made when workers work on their own and without complying with job standards. One reason for the difference in quality between Japanese products and American and European ones is that the problem of compliance with job standards is approached through QC circles, one aspect of Japanese-style quality control.

The following points are important prerequisites for enhancing awareness of the necessity of complying with job standards.

1) Thoroughly understanding the function and necessity of job standards
The principal functions of job standards incllude the following:
1) Clarifying the method of work in order to minimize variation among individual workers
2) Making technical improvement easier by giving workers a clear understanding of the current state of the job
3) Enabling foremen to concentrate on their work by relegating the responsibility and authority for work

This does not mean merely telling workers to do the job according to certain job standards: it is also necessary to explain the foregoing functions of job standards, and which aspects of the job will be improved by complying with these job standards. It is also important to respect workers' autonomy by listening closely to their opinions and making the necessary improvements when doubts concerning a job standard are expressed.

2) Making standards that workers are capable of meeting
Workers should not merely be told, for instance, to shave a workpiece to a length of 10 mm ± 0.5 mm, but also how to shave it to 10 mm ± 0.5 mm; in other words, the method to be used must also be defined. In addition, workers, no matter how hard they try, would not be able to comply with a job standard that exceeds a piece of equipment's capabilities (e.g., specifying that a furnace be set within 5° C of a certain temperature even though that furnace's difference in temperature can be as high as 20° C) or a job standard with no range of error (such as specifying only that a furnace be set to 70° C). Job standards should be achievable and not confusing to workers. Job standards must also be readily revised as the process is improved or changed. This is another characteristic of Japan's QC.

3) Providing workers with adequate education and training in job standards
Regardless of how good a job standard may be, workers can misunderstand them unless properly instructed. Thus, it is necessary to take workers by the hand and, through actual work, show them the correct method of doing the job.

3.2.4 Eliminating defective products: Maintaining the state of control

Even though a job may seem to be proceeding according to job standards, problems such as job errors or variation in materials, machinery or job methods can lead to variation in the resultant products, which, in turn, makes a certain quantity of defective products inevitable.
Such defective products must never reach the consumer, and so must be detected without fail; measures to prevent the reoccurrence of such defective products are also necessary. Below are the primary steps necessary to eliminate defective products.

Method No. 1: Controlling processes to prevent defective products
Concerning process control, which is discussed in detail in the following chapter, control points for foremen and workers must be defined, and a fine dragnet of control must be put out to prevent defective products from being made. In short, anticipatory control that checks processes by examining results (characteristics) and causes (factors) is necessary. The ability to perform such activity at the front line of the work site is another characteristic of Japan's quality control.

Method No. 2: Detecting defective products through inspection
Even if processes are being controlled, defective products will inevitably be made if process capability is deficient. Therefore, in order to provide the consumer with only good products, the quality of products produced must be checked (i.e., inspected) in order to unfailingly detect defective products.

Method No. 3: Raising process capability
Raising the capability to create quality in a process (i.e., process capability) is more important than using inspection to detect defective products and assure quality. This is because if process capability is low, yield will be poor and inspection costs will rise, no matter how strict the inspections used to assure quality are. When a process results in a large number of defects, it is necessary to ascertain process capability, determine the causes and take such steps as improving mechanical precision, providing workers with education and training and improving the quality of parts and materials. This is also an important issue for the 1980s.

Method No. 4: Analyzing defective products and taking measure to prevent their reoccurrence

When a defective product is detected, it is necessary to ascertain and eliminate the cause and take steps to prevent reoccurrence.

The following measures are particularly important.

1) Clarifying exactly what is defective
2) Ascertaining the precise conditions under which defective products occur
3) Ascertaining the cause of the defect
4) Designing concrete measures to eliminate the cause
5) Unfailingly stopping the defect from hapenning

Attention in these and other areas is necessary.

Method No. 5: Implementing thorough change control

Increased automation, labor saving and computerization mean that processes will be changed continuously. When such changes occur, the control system breaks down, creating the necessity for change control. Below are examples of the types of changes to which change control applies.

1) Changes in design
2) Changing parts or materials suppliers
3) Changing equipment, dies, or tools
4) Changing production divisions or production locations
5) Changing manfuacturing conditions or methods
6) Changing the methods or conditions of inspection or testing
7) Changing workers registered for important jobs
8) Other changes that have a major impact on quality assurance

The affected divisions must engage in prior consultation regarding such matters and carry out proper control in order to prevent problems concerning control or quality assurance in the manufacturing process, for instance.

A change control system diagram and proposal for change are shown in Figs. 3 and 4, respectively.

Thus, process control becomes possible by implementing together the five methods described above. This is also the fundamentals of control, and it is important to proceed with a proper understanding of the fundamentals, whether now or in the 21st century.

System diagram for change control

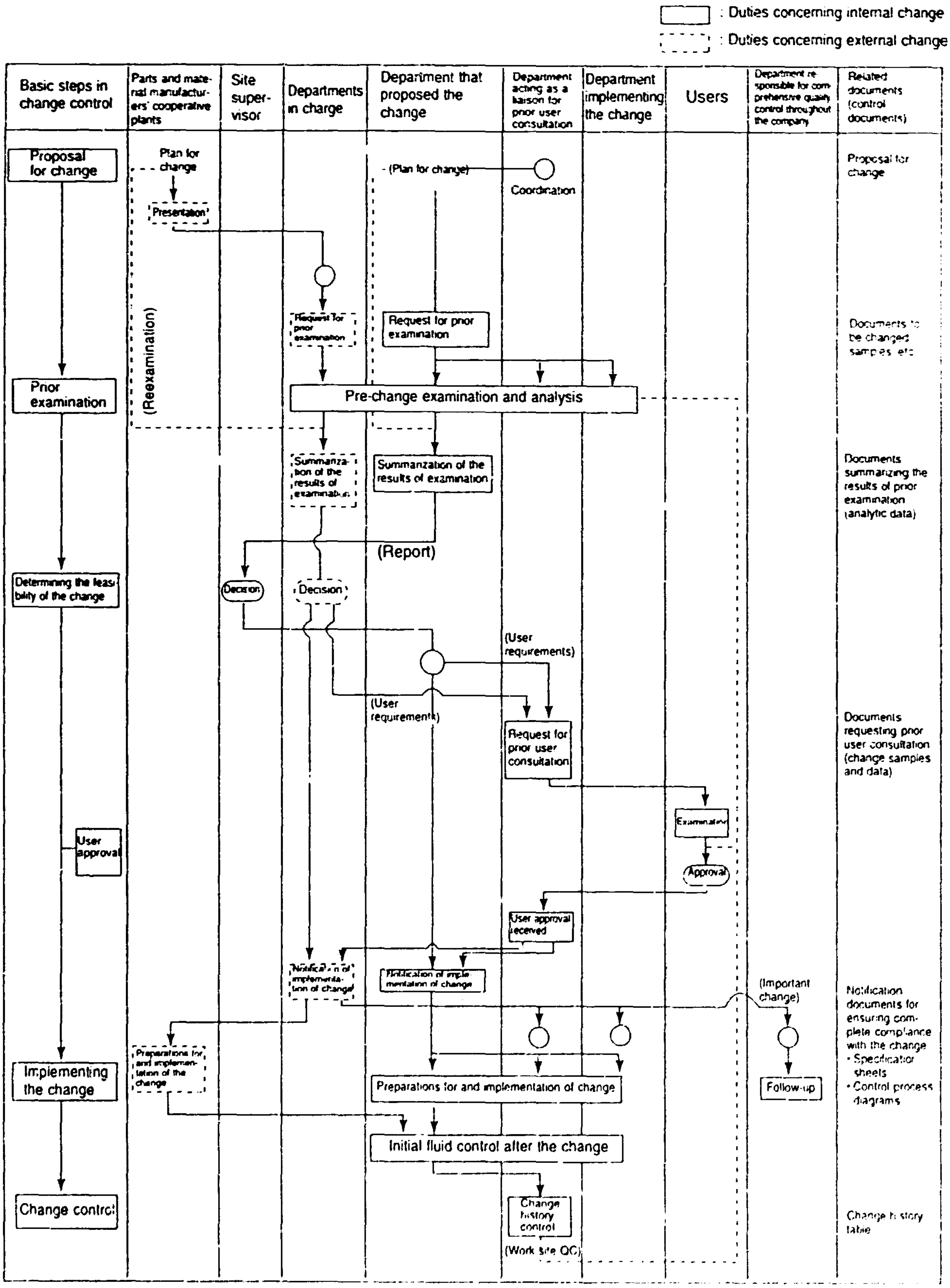


Fig. 3 An example of a system diagram for change control

No.

Date: ____________ (year/month/day)

Proposing department

Assigned department	Supervisor	Manager

Proposal for Change

This is to notify you that the following change is being planned. Please indicate whether you require process invetigation or the shipment of samples of initial products.

1. Part to be changed

Part number	Part name	Part category
		Important part / Other

2. Details of change

Before change	After change	Reason for change, affected characteristics, etc.

3. Plan for change

Time of change	Time of delivery of initial products	How initial product delivery will be indicated

---

To:

Date: ____________ (year/month/day)

Plant: ________, Dept.: ________

Section: ________

Response Sheet

Supervisor	Seal	Manager

Below is our reply concerning the above change.

(1) Process investigation and sample presentation (check one of the following):

☐ We will perform a plant investigation (date of investigation: ____________ [year/month/day])

☐ No plant investigation will be performed; please instigate thorough initial fluid control.

☐ Please send samples as requested below.

1) Sample delivery date: ____________ (year/month/day) 2) Details of samples

(2) Other information

Fig. 4 Example of an actual proposal for change

II. Process Control Planning

1. Process Control Planning

The planning functions of control activity is generally considered to include the following.

1) Defining objectives
   These objectives include quality, cost, time and quantity.
2) Standardizing by defining procedures for implementation, formalities and methods
3) Defining the procedure for assessing the results of implementation
4) Establishing the procedure for handling exeptions
5) Defining the department responsible for implementation
6) Drafting a budget
7) Drafting proposed countermeasures for foreseeable changes in environmental conditions and for each separate condition
8) Defining the importance and priority of matters to implement
9) Selecting the machinery, materials, tools and instruments to use during implementation
10) Defining the information to obtain during implementation, the standards to use, information to collect and information to relay
    This includes defining where information is to be relayed and when it is to be relayed.

In process control planning, emphasis is placed on items such as the following.

1) Selecting the processes by which design quality is to be achieved
2) Selecting the control characteristics to be used to control the processes
3) Defining process conditions using technical standards and design quality, and setting job standards with prototype information
4) Defining process control standards with control charts and QC process charts
5) Defining methods for responding to abnormalities

Fig. 1 shows the flow of planning for process control activities.
The success of control activities depends on planning in the first stage. Given the current emphasis on forward- looking activities, such planning must be precise and extensive.
The principle of exception control is always included in the basic theory of control — beginning with a proper awareness of the economic, quality — and process-related problems one currently faces. Trying to incorporate all conditions in control activities involves excessively long preparation time and excessive costs. There are also problems that remain technically unresolved. In other words, unexpected circumstances will arise even in a system designed to be omniscient and omnipotent. Consequently, the procedure for responding to such circumstances must be defined in advance.
Innovative steps are also necessary to prevent improper planning. This means analyzing cases of past failures and functionally implementing a design approach that reflects the intentions of planning.
During planning it is also preferable to plan the procedures for collecting and storing the kind of information that will be useful in the future. Objectives that are too vague will negate the value of much information.

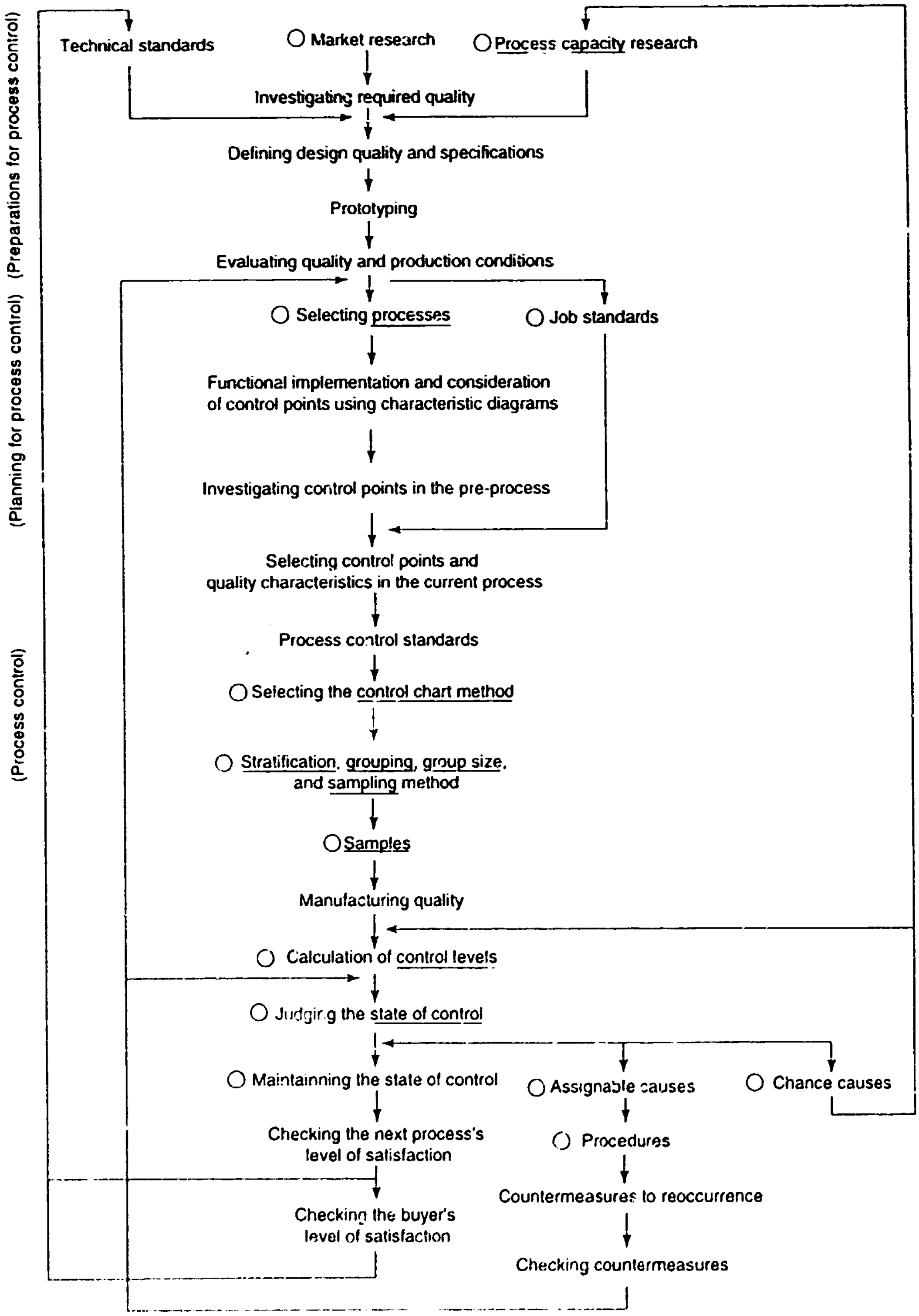


Fig. 1 The positioning of process control planning

2. Defining Control Points, Control Items and Inspection Items

During control, causes are identified and results are used to check the effectiveness of control. In process control, the process (i.e., system of causes) is judged to be functioning favorably when, after defining the control and quality characteristics, the resultant values are in a state of control. In contrast to these "characteristics," JIS Z 9021 (control chart methods) uses the term "items to control," which are also referred to by various names, such as control points and control items.

Other terms similar to "control point" include checkpoint, item for attention, inspection, inspection items, assessment points, check items, control characteristics, quality characteristics and manufacturing control characteristics. There are no particular JIS prescriptions concerning terms. Here, the term "control point" is used as a general term encompassing all of these other terms. Items used when autonomously ascertaining and checking a process's system of causes in order to carry out process responsibility are called "inspection items," while the terms "control item," "control characteristic" and "quality characteristic" are used to refer to the items used when checking or investigating process results with the objective assuring quality. In a process, responsibility for QCD is assumed. As general terms, "control item" and "control characteristics" would seem satisfactory. "Quality characteristic" would seem especially appropriate for process control based on control charts. However, it is important to strive for consistency (when appropriate) by defining terms according to in-house standards. In fact, the first step in promoting quality control is the use of common terminology throughout the company. This is because a superficial interpretation of a term can cause unexpected confusion. Students asked, "What is quality control" reply matter-of-factly, "The control of quality." Caution is required to prevent things like this.

3. Defining Control Points

The method of defining control points naturally depends on the objectives and control level of process control. Creative innovation is called for to enhance efficiency by devising an easy-to-use method suited to circumstances.

3.1 General Problems Faced When Defining Control Points

1) How to prevent control points from being overlooked
2) How to define the importance of each control point and how to select the priority control items
3) How to correlate processes
4) How to correlate control points with design quality
5) How to organize and integrate control points
6) How to quickly ascertain the status of control
7) How to prevent the misunderstanding of control points
8) How to prevent the defining of control points from taking too much time
9) How to adapt control points when rapid changes in environmental conditions are made

These and other problems are conceivable. The principle of quality control is to ascertain the current state of affairs and proceed in a manner grounded in facts. When a current problem is vague, its solution will also be vague.

3.2 Information Used to Define Control Points

This includes information concerning the intentions behind planning and design; required quality; design quality; prototyping; quality and processes during the initial fluid period; capacity of the current process; control points for the pre-process; the structure of quality assurance; and technical and job standards used in processes.

Many required qualities are specified qualitatively. Using the case of an alarm clock as an example, such qualities would be, for instance:

1) A sound that wakes the user gently
2) A unique design
3) An easy-to-read time
4) A reasonable price
5) An alarm that is easy to set

These qualities are converted to substitute characteristics in order to raise reproducibility and producibility. In contrast to these characteristics, design quality is determined by averages, distribution and tolerance, necessitating that the proper methods of conversion and assigning values be selected.

Quality characteristics such as the raw materials and parts that serve as product components are determined at the same time as the product's design quality. At the same time, the machinery used, tools, job method, job procedure and other process conditions, along with job emphasis, for example, are also decided, thereby establishing the job standards. Problems common to the entire process are resolved with specific technology and production technology, and established technical standards are applied to problems unique to a certain product or process. Then, in accordance with the process's specifications, design quality and job standards, prototypes are made and assessed with respect to required quality. At this time, it must be decided which control points to assign to which process. Design changes and prototyping are repeated until quality, cost, productivity and other requirements are satisfied. When these changes are made, control points and job standards are reexamined and amended. Poor handling of information concerning changes can impede control of the main production process. Large amounts of information are generated prior to the initial fluid period, and this information must be processed speedily so that the most recent, most appropriate infomration is used throughout the entire process.

When defining control points, one must strive to solve problems for the entire process, rather than thinking only of one's own process. Here is one example: There was a problem with the warping of PCBs in a soldering process, but an investigation revealed no pattern in the location of occurrence. However, upon determining that cutting directions were inconsistent in the PCB cutting process, it became apparant that warping occurred in the substrate's longitudinal direction. Detecting this pattern led to a solution, making it possible to omit the control item of PCB warping. Reoccurence of the problem was prevented by listing this case in technical standards and in collections of quality analysis cases.

4. The Method for Defining Control Points

In process control, control points are defined and their values used to ascertain the status of the process. There are many potential causes in a process, and so job standards are followed in order to maintain the process (i.e., the system of causs) in a favorable state during production. However, assigning personnel to check each of these causes and verify whether work is being performed properly during normal production entails considerable efforts yet is limited in effectiveness. Instead, workers autonomously inspect their own work, maintaining the process in a favorable state while also checking the control characteristics of production results; when these results indicate a favorable state, that is, a state of control, the process is considered favorable. This approach is known as process control. It is pointless unless the control characteristics at this time are satisfactory. Thus, the question is how to devise a method of defining effective control points, a question that has prompted considerable innovation.

4.1 The Method for Selecting the Items to Control

Below are the guidelines for selecting control items for process control based on control charts.

1) Thoroughly ascertain which quality characteristics of the product represent the user's required quality and select those control items that are importantly related to the objectives of use.
2) Select not just the final product quality characteristics, but also the quality characteristics of the materials and semifinished product based on the reasonable requirements of the next process.
3) Although it is acceptable to select characteristics after the machinery, etc., has been assembled, also select the quality characteristics and manufacturing conditions of each part in the processes prior to assembly; identify those control items that should be controlled in those processes.
4) Select processes that are important in terms of quality and which are easy to measure and easy to take corrective measures against in the process.
5) When direct measurement is technically and economically unfeasible, select the quality characteristics or manufacturing conditions closed related to the affected quality characteristics.

Details concerning process control based on control charts is discussed in the next chapter.

4.2 Control Characteristic Enumeration Methods

The more individual characteristics there are, the more difficult it is to enumerate them. Even length, for instance, involves many characteristics, such as width, thickness, diameters (external and internal) and depth. Tables 1 and 2 list these control characteristics in order to prevent ommission.

Physical control is characterized by the use of CGS units, which comprise three components (length, weight and time) used in combination to measure. These combinations include surface area, specific gravity and speed. Recently, sensors have come into frequent use to measure by converting into electrical characteristics. One example is a method for measuring an object's flatness: The object is shined with light; the reflected light is passed through a photocell and measured as an electrical characteristic.

The system of SI units comprises length (m), mass (kg), time (s), current (A), thermodynamic temperature (k) and luminous intensity (cd); used as auxiliary units are plane angle (rad) and solid angle (sr). A variety of units are derived from these units.

A characteristic chart enumerates the factors of a single characteristic. The characteristic itself should also be thought of together with good quality.

Odor may at first seem unrelated to electrical products, but a "futon" dryer, for instance, gives off a very unpleasant plastic smell when first used. Refrigerators also involve the problem of food odors that they picked up. These problems would seem preventable by incorporating the corresponding control points somewhere in the process.

Table 1 The elements of control characteristics

Performance CGS units Physical characteristics (those that stimulate the sense of sight, hearing, taste and smell) Reliability and durability Maintainability Safety (mechanical, chemical and electrical) and harmlessness Cost effectiveness Ease of handling, workability, practicability and operability Comfort Serviceability Compatibility and expandability

Table 2 CGS characteristics

	C	G	S
C	Length Area Volume		
G	Specific gravity Concentration Moment of inertia	Weight	
S	Speed Acceleration Flow	Fineness (denier)	Time, rotations Time Period Frequency

4.3 The Quality Expansion Method

This entails expanding required quality into design quality and then to control points.
See Tables 3 through 5 for examples of expansion.

Table 3 Expansion of an alarm sound

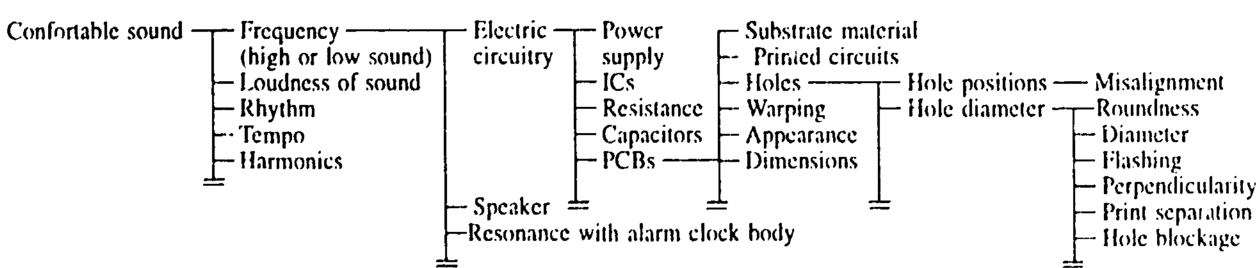


Table 4 Expansion of the required quality of rubber gaskets

Preventing leaks —┬— Shape → Dimensions → Length, Thickness, Diameter, etc.
├— Durability → Tensile strength, Flexibility, Brittleness, Hardness, Warping, etc.
├— Weather resistance
└— Appearance → Scratching, cracking, flash, etc.

Table 5 Quality expansion related to safety

Required quality	Design quality	Control item
Safety	Mechanical safety Strength Compressive strength Tensile strength Flexural strength	Materials Heat treatment temperature Heat treatment time Ambient gas components
	Shape	Flashing, kurtosis
	Chemical safety Amount of heavy metals used Amount of organic solvents used Corrosion	Elution Thickness of surface film
	Electrical safety Static electricity Voltage resistance Power consumption	 Physical properties of anti- electrostatic agent Resistance Temperature

4.4 Methods Based on Important Quality Item Tables

This is used to indicate items such as the following: target values for required quality and important quality items, design emphasis items, quality assurance items; and quality assessment, process planning, process control planning and related standards in the design, prototyping and mass production stages.

4.5 Methods for Analyzing Process Functions

This entails process analysis designed to ascertain the functions of each element and determine the following with respect to the system of factors.

System of factors : Inspection items, acquired information (e.g., design specifications and process control results), inspection methods (point of inspection, inspection intervals, sample size, method for identifying abnormalities, and response procedure), work standards (facilities used, tools, work methods and procedure), persons in charge and supervisors, etc.

Results : Control items, information to relate, control methods (stratification, grouping and sampling), method of identifying abnormalities and response procedure), persons in charge and supervisors, etc.

4.6 Methods Based on Two-Dimensional Tables of Defect Phenomena and Causes

This method involves classifying defect phenomena and analyzing correlations with causes using two-dimensional tables. Examples of defect phenomena include problems with appearance, mechanisms, electrical characteristics, reliability and safety.

Causes include equipment, materials, work methods, workers and control methods.

4.7 Methods Based on Combinations of Two- Dimensional Tables

This involves consolidating into a single table multiple tables prepared separately: 1) required qualities (A) and design qualities (B), 2) design qualities (B) and control items (C), 3) control items (C) and inspection items (D), and (4) inspection items (D) and required qualities (A). When preparing a two-dimensional table, omitted items and correlations between items are frequently noticed.

In the case of a pencil, these items would appear thus.

Required qualities (A) : Smoothness, the core's resistance to breaking, ease of sharpening, erasability of written letters, appearance, ease of gripping, resistance to smearing and indicated quality.

Design qualities (B) : Raw material quality, hardness and strength of the pencil core

Control items (C) : Heating temperature and component purity

Inspection items (D) : Raw material result tables, instrument precision
These are shown in Fig. 2.

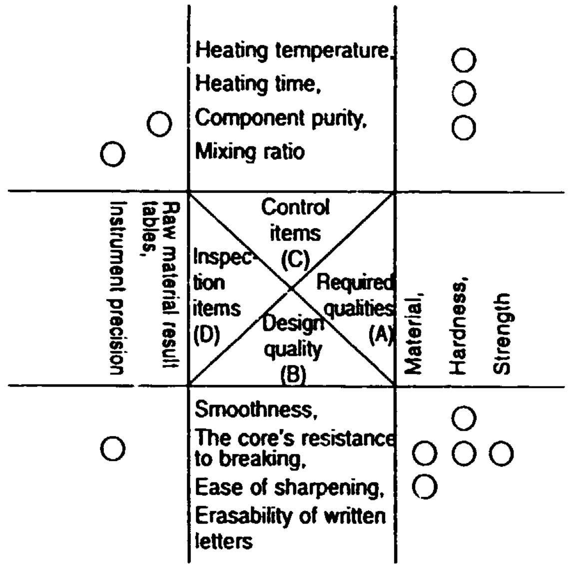


Fig. 2 Combinations in a two-dimensional table

5. QC Process Charts and Process Control Standards

A QC control chart is prepared, for quality assurance purposes, by setting control points for each process according to the flow and procedure of the production process. The objective is to ascertain the relationship between processes and detect as many abnormalities as possible in the preprocess. As a single chart can contain large amounts of information, this graphic representation makes it possible to understand the entire system of process control at a glance.

Problems encountered when preparing QC control charts include the following.

1) The precision of process analysis (i.e., how closely to analyze a process)
2) The clarification and relegation of responsibilities and authority
3) Innovations concerning standardization, similar products and similar processes
4) Determining whether concentration or dispersion is the problem with respect to control characteristics.
5) Information from the initial fluid period is not yet incorporated.
6) Related standards are not organized.
7) Methods for making revisions in response to process changes.

Table 6 The precision of process analysis for press die mounting

- Die mounting
  - Die mounting
    - Checking die quality
      - Checking appearance
      - Checking shape
    - Die mounting
    - Die fastening
    - Checking mounting
      - Checking position
      - Checking torque
  - Material setting
    - Material setting
    - Checking setting
    - Setting the position detector
  - Inspecting initial products
    - Appearance
      - Flashing
    - Shape

The necessity of process analysis and the objectives of control determine how detailed process control will be. In Table 6, which uses a pressing process as an example, analysis is limited to die mounting if process control for it is successful, but performed with greater detail when problem solving is unsuccessful.
Responsibility, authority, work standards and change control have already been discussed, and so are omitted here.
QC process charts, being applied to process control, were conceived to solve the kinds of problems presented here.
The items entered on a QC process chart include workplace name, process name, process flow, control applicability (materials and products, for instance), control points (control items and inspection items), persons in charge, control times (i.e., times and time intervals), the methods of stratification and grouping, sample size, method of measurement, data entry format names, methods for collecting and relaying information, methods for judging the state of control, the procedure for responding to abnormalities, related standards, process capability and emphasis in control.
Fig. 3 is a QC control chart that shows control points only. Actual examples of QC process charts are presented as a principal theme of Issue 4, Vol. 26, of "Quality Control."
These QC process charts are registered as process control standards and used to standardize control activity. This use of standards can be thought of as similar to that of work standards, for instance.

	Control point	
Process	**Control item**	**Inspection item**
Material ↓		The material's quality assurance system Lot No.
Mixing ↓		Mixing ratio Machine history Stirring time and speed
Rubber sheet forming ↓	Thickness Appearance (surface)	Amount of material used Roll rotation speed
Cutting ↓	Thickness Appearance (cut surface)	Blade history Blade mounting Cutting speed
Vulcanizing ↓ ═	Dimensions Appearance (flashing and surface) Hardness Tensile strength	Die history Die shape Difference in die shapes Press pressure Temperature Time Instrument accuracy and precision

Fig. 3 Control points in a rubber gasket manufacturing process

Table 7 Rechecking control items

Process	**Control item**	**Process where an abnormality was successfully detected**	
		P1	**P2**
P_1	y_{11}		○
	y_{12}	○	
↓	⋮		
	y_{21}	○	
P_2	y_{22}		○
	⋮		

Criteria used to select important control items include impact on the post-process, urgency prior to solution, and the potential of control in one's process.
The process flow determines the control items, the appropriateness of which must be rechecked. Let us assume that control item (y_{ij}) has been determined for each process (Pi), as shown in Table 7. Here, one checks where a process abnormality was detected and what kind of revisions should be made to make detection possible. In this example, control items y_{12} and y_{22} are acceptable as they are, but for y_{11} and y_{21} it is necessary to recheck whether there are problems with either the process or the control items themselves.

6. Problems in Process Control

When implementing control activities, it is necessary to first clarify the objectives of, and problems related to, those activities.

1) Investigating Control Characteristics

To initiate process control, the control characteristics of the process (i.e., the items to control) must be selected. These control characteristics must be suitable for the required quality and design quality in question. The quality characteristics required, in turn, can be very numerous, depending on how diversified the product is and how high its value-added is, and can also change in importance in a short period of time, as can the quality levels. Consequently, the method of selecting and changing these control characteristics in response to such changes is very important.
To assure quality, a process must be maintained in a state of control. Even if a state of control is maintained, however, it will not be possible to assure required quality or design quality if the control characteristics are inappropriate. Thus, while process control is a necessary condition for quality assurance, it is not a sufficient condition. However, innovations for bringing this insufficient condition as close as possible to sufficient are important.

2) Methods of Factor Analysis

Even if control characteristics are appropriate for design quality, the cause of any process abnormality that occurs must be promptly ascertained and eliminated and steps to prevent recurrence taken. Responses to abnormalities are often delayed due to analysis on the interrelationships of these characteristic factors that is not sufficiently comprehensive or detailed.
Merely collecting characteristic values during data compilation does not ensure a solution. Instead, the processes in the system of causes are stratified and grouped. It is also very important to prepare data sheets to clarify stratification and grouping, and to systematically record the process information obtained. Also needed are steps to train personnel to judge processes during everyday operations. In short, factor analysis becomes possible only when factors and characteristic values are correlated.

3) Standardization Based on Current Circumstances

Standards in process control include standards used to ascertain causes; standards used to check results; standards for expediting the organization and administration of control activity; and standards for checking whether control activity complies with standards.
The setting of these standards, the procedures for revising and abolishing them, and positioning in the system of standardization, among other aspects, must be given consideration.
Although inadequacies in the standards themselves are not fatal, there must be simplicity and clarity in the actual application of these standards.

III. Preventing Human Error and Foolproofing

1. The Essence of Human Error

Human error is often seen as troublesome, a nuisance and bad. Nonetheless, just like the law of nature, human error has its own reason for existence. The essence of human error is such that its occurrence can be prevented from leading to even worse events — much like a fuse in an electric circuit. It is also frequently necessary to recognize the role of human error as a kind of safety valve.

The manner in which human error occurs not only depends greatly on individual characteristics, but also varies considerably according to TPO. The effect of ambient factors is not one of a main effect but rather interactive. Another frequently observed tendency of human error is that once it occurs, rather than being prevented, it is more likely to increase in frequency, whether among individuals or groups.

Human error can be reduced but never eliminated. Although one may wish to learn the extent to which human error can be reduced, this limit is by no means permanent or immovable; considerable variation is normal. In short, the nature of human error is such that it is always unclear which errors are unavoidable and which can be eliminated.

Human error is often thought of as something that is done unconsciously. In reality, however, it is not that simple, and only seldom is it determined whether a human error was committed consciously, unconsciously or somewhere in between. Human error is even sometimes committed in the mistaken belief that the action is the correct one. Moreover, one cannot even rule out the possibility that an error was committed intentionally but merely made to look like an accident. Also, human error is also associated with group mentality, with blindly following what others are doing.

In computer programs, a glitch that is put into a program unconsciously is called a bug, but if done consciously, would be considered completely criminal. Thus, the problem of errors is inextricably linked with morale. In short, the problem of human error must be carefully examined in terms of quality as it relates to people not logically, but also ethically. Typically, human error is "foolish" actions that occur in a foolproof system.

2. The Essence of Foolproofing

Foolproofing can be observed in many aspects of society and daily life. In the private sector, its effectiveness as a preventative measure is widely recognized for a variety of situations.

The word "fool" in foolproofing means many different things. According to the Random House English-Japanese Dictionary, it means "a stupid person, idiot, imbecile, dunce. an insensible person, a clown, buffoon, a retarded person, a dull person, or enthusiast."

In short, the word "fool" implies circumstances that are not normal. However, such is the nature of the word "normal" that it is hard to define when asked, "What is normal?" Even if defined, what is "normal" is never permanent, differing considerably depending on perception, which, naturally enough, is just as applicable to the general aspects of human error.

As foolproofing has been in use for many years, it is often approached in a lackadaisical manner. However, foolproofing requires not just attentively creating the foolproofing system itself, but also acquiring the discipline needed for its implementation, maintenance, revision and abolition, and also the flexibility needed to gain acceptance among others. In short, foolproofing should function not as an alien presence in the overall system, but as a completely integrated presence.

The original significance of foolproofing is as an consolidation of the preparations and discipline needed to expedite the functions of a system. This means that the noncompliances that occur in its absence should far exceed those that occur when it is functioning. Frequency of use is not always the problem.

3. Foolproofing That Is Firmly Rooted in Human Error

Broadly speaking, foolproofing is a response to foolish actions seen as human error. Consequently, off-target products will result unless foolproofing is based on the realities of human error. Merely implementing foolproofing should not be reason to feel at ease, as one never knows when a new foolish action, compound foolish actions or domino-effect-like foolish actions will occur.

Moreover, initiating a new foolproofing mechanism can trigger new types of foolish actions. In short, foolproofing is constantly threatened by the possibility of the appearance of a previously unknown type of foolish action. Therefore, rather than implementing foolproofing as a separate countermeasure similar types of reinforcements should also be made use of.

Foolproofing functions were originally envisaged as a type of error recovery, which encompasses not just foolproofing, but also two other functions: fail-safe, which is designing a system to switch to its safe state in the event of failure; and fail-soft, which gradually stops a system's functioning. As today's systems become more complex and diversified, fail-soft functions, such as those already in use in online, realtime information processing systems, will become essential is a variety of forms.

To summarize, in order to prepare for and respond to the dynamic adversary called human error, all three error recovery functions — foolproofing, fail-safe and fail-soft — must be combined and arranged in a well-balanced way. This approach means actually making use of characteristics normally considered useless and harmful — in other words, it is a question of ideas.

4. Recommendation

Naturally, cost-effectiveness is a basic precondition for foolproofing treated as an error recovery function. In addition, rather than relying merely on physical countermeasures, ethical and mental considerations are also important.

Particularly in view of the amazing progress being made today in CAS (Computer Aided Systems), which makes use of computers both openly and in the background, the threat of computer crime is gradually creeping various new areas.

Therefore, in order to assure its effectiveness in a broad range of areas, foolproofing must continue to be clearly positioned within the larger context of error recovery functions.

In short, countermeasures that take the larger context into account are needed; measures that can't see the forest for the trees will have effects that are opposite from what was intended. Proper caution is required to prevent overreach and repercussion effects, in particular.

It must also be remembered that, now just as in the past, foolproofing cannot always satisfy both safety and convenience requirements simultaneously.

Moreover, there are no immovable, universal or permanent measures. Keeping this in mind, completely dedicated, unwavering efforts and persistence are also essential.

5. Human Error and Foolproofing in Equipment Maintenance

5.1 Introduction

The steel industry, in order to make high-quality, low-cost products, has continuously striven for more advanced technology, larger machines, greater automation and high precision, thus developing into an equipment-dependent process industry.

Because of these changes, production activity has undergone an extensive qualitative transformation, with both quality control and process control being systematized and improved.

In equipment maintenance, as well, both intrinsic technology and control technology have been improved by efforts to satisfy the various operating needs of both production activity and the activities that support the system of production. Although the objectives and activities of maintenance (i.e., comprehensive support) are clear, the problems associated with the methods and processes used to achieve these objectives are extremely complex and extensive. With respect to the nature of the work involved, actual maintenance (that is, inspection and planning) is based almost entirely on people's experience and on the judgments based on that experience, while repair (work and fabrication) are based almost entirely on skill. Thus, neither are readily understandable to people from other areas. In addition, the above-described nature of maintenance — its wide range, dependence on individual judgment and skill, and the complexity of processing, for instance — impedes uniformity and standardization and leads to a variety of human errors.

5.2 The Characteristics of Equipment Maintenance

Table 1 The characteristics of maintenance

1. Functions, division of duties	Broadly divided into maintenance (inspection and planning) and repairs (with some operation). However, there are many philosophies concerning interconnections with manufacturing.
2. Regional scale	Dispersed over a large area.
3. Organization	A variety of options, including integrated, distributed and eclectic ones.
4. Specialized techniques and skills	An amalgamation of specialized and versatile professions.
5. Types of equipment	From process industries to mechanical industries
6. Working conditions	Often demanding
7. Personnel	A combination of direct management and subcontractors (with a high rate of subcontracting)

From the January, 1981, issue of "Steel IE."

Table 2 A comparison of maintenance and production (the nature of work)

	Maintenance	Production
1. Who performs work	People	Equipment
2. Personnel assignment	Fluid or flexible	Fixed
3. Shifts	Generally all day	4 watches, 3 shifts
4. Work pattern	Unsteady (non-repetitive)	Steady
5. Nature of work	Often involves judgments and coordinating	Mainly standard work
6. Value judgments	Choosing between PM and BM Unclear, such as determining the correct amount of PM	Relatively clear assessment
7. Work pace	Large individual differences in capability Workmanship needs make time management difficult	Almost all work can be contained within a fixed standard time
8. Workload	Depends on deciding factors, complex business conditions and policies, etc.	Linked to output
9. Type of control	Abnormality control	Standard control

From the January, 1981, issue of "Steel IE."

Table 3 A comparison of maintenance and production (contra indicators)

	Maintenance	Production
1. Type of indicators	Lack of clarity	Simple and clear
2. Final objective	Reducing the total costs of maintenance (i.e., the sum of the costs of maintenance and restoration and the costs of loss resulting from diminished equipment functioning)	Profit
3. Amount of activity	Total mandays (personnel invested) and materials used	Production tonnage
4. Efficiency of activity	Equipment output Equipment input Input measures the amount of activity, while output depends on improvements in reliability, safety and precision, etc.	Tons/hour, yield, unit
5. Period assessed	Longer periods are desirable (one quarter to several years)	Short periods are desirable (days, weeks, months)
6. Cost indicators	Complex calculations	Costs/ton
7. Budgeting	Based on separate calculation, desired ranges and policies	Almost completely linked to production plans
8. Means of improving morale	Goal management and a sense of responsibility in one's area through self-completion job planning	A sense of group achievement achieved by reaching production goals

From the January, 1981, issue of "Steel IE."

Table 4 A comparison of maintenance and production activity (input items)

Activity input items	
Maintenance	Production
Workers	Equipment
Information	Systems
Materials and equipment	Workers
Total mandays	Raw materials
Systems	Energy

Note: Items concerning each type of activity are listed in order of importance.
From the January, 1981, issue of "Steel IE."

Tables 1 through 4 are comparisons of the principles of equipment maintenance and production, the natures and characteristics of which are clear and readily understandable.

As Table 4 is particularly related to the issue at hand, a supplementary explanation is given below.

Production is independent in nature, making it relatively conducive to standardization, automation and systemization, and has input items that are considerably high in reliability. Maintenance, on the other hand, is an amalgamation of elements that are auxiliary in nature and therefore unconducive to standardization, automation and systemization; its input items are of questionable reliability.

Today's advanced control technology notwithstanding, maintenance is still founded on the level of quality of maintenance information; on the quality and morale of maintenance workers; and on the quality of materials and work. These foundations, now as before, support control technology and affect the results of maintenance.

Another matter that must be mentioned is the wide range of maintenance. Particularly in an equipment-dependent process industry like the steel industry, it is equipment that actualizes products and quality, greatly affecting labor productivity and how much energy is saved. Naturally, equipment maintenance is not limited to reducing repair costs or maintaining and restoring functions by reducing breakdowns, but instead must also maintain and improve equipment functions by satisfying the broad range of needs in operation (e.g., quality, yield, unit and productivity).

Refer to Fig. 1 for an equipment control system that indicates the nature of equipment maintenance activity.

5.3 Equipment Problems (with Inspection and Planning) That Lead to Human Error

Inspection can be defined as "organized activity in which equipment conditions are ascertained, changes and deterioration in functions are anticipated, and proper measures are taken in advance."

5.3.1 Ascertaining Equipment Conditions

In production, principal operation information and quality data are continuously collected and recorded online and used in post-process inspection, investigation and analysis. In contrast, continuous monitoring of equipment conditions is extremely rare.

Generalized types of monitoring include abnormality monitoring for important equipment and auxiliary equipment (e.g., hydraulic pressure, pneumatic pressure and lubrication systems), which is has been devised to prevent accidents in important equipment, reduce manpower in inspection work, and prevent errors in inspection itself.

What makes this type of monitoring different is that it centers around abnormality monitoring, not on measurement of the constant state of a system or device. Of course, follow-up inspections of operations through the continuous monitoring of torque, as well and operations analysis based on the measurement and monitoring of vibration, are used in some locations, and AE inspections of crack spreading in spindles are also performed, but these are only carried out according to special, limited equipment or needs; they are not generalized.

Consequently, the discussion here centers around the five senses as used during cyclic inspections; regular (and emergency) diagnosis performed with diagnostic tools; and on past records (accident records and work records, for instance) and external information (from machine manufacturers and competitors in the same industry). Also used is operation information (from operators) and quality information, which together enable the comprehensive condition of equipment to be known. At this stage, human error occurs at many different levels.

(1) Oversight and Corner-Cutting in Inspection

While inspection during an abnormality is of some interest, inspection under normal conditions primarily involves checking, a dull, boring routine not suited to human nature. People begin to cut corners and make omissions as they become more experienced. Responding to this with standards and superficial measures to make workers comply with these standards is the inappropriate approach. Instead, we have significantly reduced the manpower involved in inspection work itself by improving the reliability of equipment and using more failure detectors.

(2) Inspections That Fail to Detect or Predict Abnormalities

This is a difficult problem. Arduous experience is the best teacher, but the ultimate strategy is on-the-job training that boosts workers' morale, improves the quality of their work and raises their awareness of the problem. Maintenance personnel, in particular, tend to possess inadequate knowledge of operations, and better interpersonal relations and information exchanges with operators can provide stimulation.

(3) Inspections That Detect or Predict Exaggerated Abnormalities

This problem often involves workers of relatively low technical levels.

Nonetheless, this is a problem when the criteria in question are not necessarily objective, and so it is important to enable the workers in question to make judgments based on objective data whenever possible by providing them with education and training and by having them use diagnostic devices.

5.3.2 Predicting Deterioration in Functions

It is this problem that involve techniques that would more appropriately be called equipment maintenance know-how. It is also a very vexing problem for us.

Traditionally, preventive maintenance is considered as the cost-effective prevention of breakdowns and problems by periodically inspecting, replacing and overhauling predetermined important equipment and parts.

However, industry still hasn't found the answer to the question, What are the objective technical standards for determining the times for inspection, replacement and overhaul? This will continue to be an important question.

Nonetheless, we are faced with the practical problem of using diagnostic devices and accumulated technology to determine times believed to be appropriate (here, the term "time" refers to the time of maintenance). In this sense, there is conceivably a considerable difference between actual lifespan and forecast lifespan, and so in the broad sense human error is committed in groups.

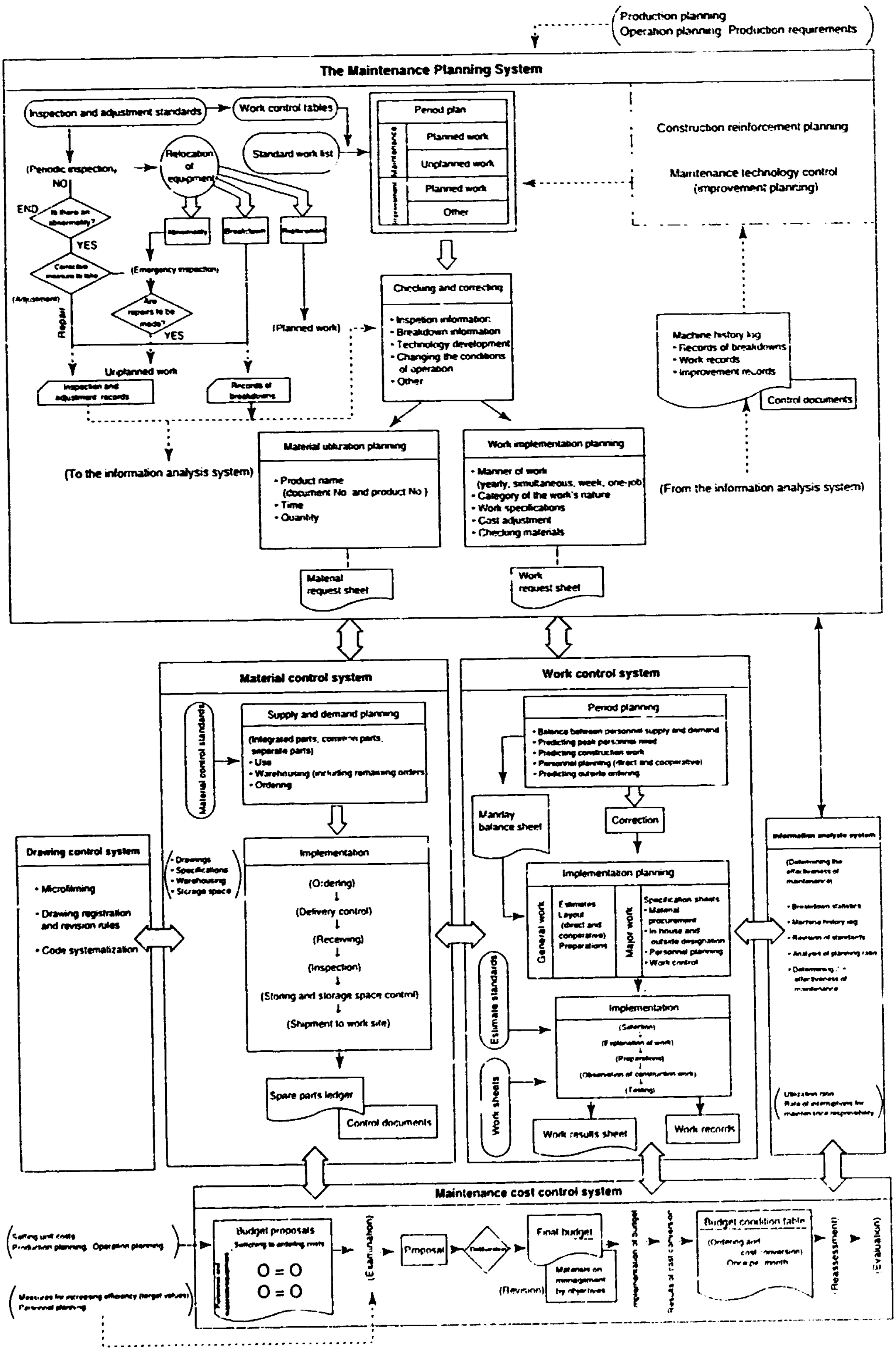


Fig. 1 The equipment maintenance control system

5.3.3 Planning Appropriate Measures

The culmination of inspection is work planning. In our case, work planning and work implementation are separate specialized fields; inspection personnel, after defining the work specifications, secure the materials needed in work and make work orders.

In this area, the issue of whether a certain measure is appropriate or not is constantly faced. However, because there is no end to qualitative debate on the subject, this discussion will limit itself to human error in the narrow sense.

(1) The Ambiguity of Work Specifications

Inspection personnel work closely with plant equipment in an environment in which technology and experience are accumulated, and so possess large amounts of existing empirical information. This sometimes leads them to draft specifications sheets without properly understanding the position of those who inspect plant equipment and perform work as it is needed.

Also, work specifications based on operation and quality requirements can sometimes be ambiguous when relayed from operators.

To prevent these problems, work specification sheets are prepared after standardizing all information items related to the work in order to prevent omission of the items themselves, and by generally requiring the attaching of drawings, for instance.

Also, joint conferences with work executors are established and held regularly, as are conferences to consider whether work information is being relayed properly.

5.4 Problems in Repairs (Related to Work and Fabrication) That Lead to Human Error

Work executors are a group of people possessing a set of common skills (such as finishing, can manufacturing, piping or scaffolding erecting) used to perform work on a broad range of equipment efficiently and while constantly leveling the workload. However, repair skills, despite being at a certain level, are relatively lacking in information on the particular conditions of plant equipment. This is even more so in the case of cooperating companies and construction work companies at work sites.

Thus, relaying work information via a given medium as part of the administration of operations entails considerable difficulties, and so executors are divided into groups that specialize in a certain limited type of equipment, while repairs on common devices (such as pumps, fans, cylinders, compressors and cranes) is made a specialty.

Thus, mistakes in work occur in a wide range of ways.

5.4.1 Starting Work Without Proper Understanding of Work Information

Although some problems are due to inadequacies in owners' work specification sheets, work executors also tend to think in terms not of documents and drawings, but work sites and objects, which leads to work mistakes. Today there are still problems with the too few questions regarding work specification sheets and too few complaints and suggestions inadequacies in them.

5.4.2 The Prior Examination of Work Is Inadequate

Work is not always routine, nor are there complete job standards. Work executors, consequently, unlike operators, must ascertain work contents and clarify procedures, methods and safety measures each time new work is undertaken.

As a result, it is important to create a workplace atmosphere and job structure that promote prior examination planning in small groups.

IV. Process Control with Control Charts

1. Preconditions

A control chart is a chart containing control limit lines statistically and rationally based on group variation. Control charts are advantageous because, recognizing dispersion in data, they use control limit lines to objectively assess the state of a process and achieve control of that process rationally and economically.
The role of control charts in process control is to objectively detect abnormal conditions.
Therefore, in process control based on control charts, when process abnormalities occur, the control charts themselves must indicate proper signals, and radical measures must be taken to ascertain and eliminate the cause.
Although easier to prepare because of relatively uncomplicated statistical methods, control charts are difficult to use; considerable effort is required to use them effectively.
Although various types of problems have traditionally been considered not conducive to charts, this discussion focuses primarily on how to use control charts.

2. Preparations for Using Control Charts

Certain preparations must be made before controlling a process with control charts. One of the main reasons that control charts have not been used more extensively at work sites is insufficient preparations for control chart use. The saying, "Preparation is the key to success" is particularly relevant to the use of control charts.

2.1 Education and Training

A proper understanding of control charts must be fomented before control charts are used. Control chart education includes education on how to make control charts and education on how to use them, of which the latter is particularly important. Without proper education on the use of control charts, control chart use at the work site will be inadequate. Actual control charts, used at actual work sites, have been an effective tool in education on control chart use. Also, section chiefs, department managers and other members of management, not just staff members and workers, should participate in actual education in order to assure adequate understanding of control charts. This is because section chiefs' and department managers' inadequate understanding has been cited as one reason for the ineffective use of control charts. Specific examples of this approach include symposiums to which outside authorities are invited, meetings at which results achieved in-house through control chart use are presented, and tours for other companies' representatives.
In many cases of results achieved with control charts, research sessions that also served as study sessions were also established. Professor Oba of the Science University of Tokyo advocates case study sessions. Past examples of research sessions, etc., include those at Japan Victor, which had established a control chart subcommittee, while recent examples include San'ai Kogyo, which has achieved results with chart promotion teams and chart promotion section meetings; and Matsushita Electronic Components Co., which has been successful with this process control research sessions.

2.2 The Organized Use of Control Charts

Proper quality assurance become less likely when process control is performed in different ways by each section, person in charge and team; it must be implemented in an organized fashion by the entire plant. And a part of this process control must be the organized use of control charts. To do so, the following must first be ascertained.

a) Clarifying who will do what in each process

In order for process control to be organized, responsibility and authority must be clarified, which includes methods of control, methods of judgment and how to take corrective measures. The standards for these elements are called control standards, which generally consist of items that define parameters like the following.

1) What the objectives of control charts are
2) Who performs sampling when and in what manner, and how many times measurements are made and data collected
3) Who plots points on control charts when and in what manner
4) Who looks at control charts and at what intervals
5) Under what circumstances is a process to be judged not to be in a state of control
6) Who looks for the causes, and in what way, when the process is not in a state of control; what measures are to be taken; and what is to be done when the cause is unclear
7) What measures are to be taken when a state of control has continued for a long period of time
8) Who calculates control lines and when, who recalculates, and with whose permission are entries made

b) Defining the methods and routes for relaying information

This entails clarifying what information is relayed to the related departments when a point falls outside the limits, how this information is relayed, what the route of the information is, and where reports are made. In many cases, when a point falls outside the limits, a process abnormality report is prepared and sent along the predetermined route. Process abnormality reports are used in the progress control of abnormality countermeasures, and for their important technical information, and so their control must be clearly defined.

3. Process Control Based on Control Charts

There is a procedure for process control based on control charts. This general procedure is described below. When steps in this procedure are omitted or skipped during process control with control charts, proper process control is no longer possible. Characteristically, in process control based on control charts, the proper control characteristics are first selected and process is improved according to careful process analysis, after which time control lines are extended and points entered on a daily basis. Then, when a point falls outside the limits, measures to prevent recurrence are taken.

Procedure

a) Select the control characteristics.
b) Select the control charts to use.
c) Collect data.
d) Use the control charts to group, stratify and analyze the process.
e) Once the control charts are in a state of control, their control limit lines are extended into control lines. At this time, be sure to adequately compare and contrast them with standard values and target values, etc. Also set standard (such as job standards).
f) Prepare control charts for control.
g) Perform sampling and measurement according to the predetermined method, then plot the data on the control charts.
h) Use the plotted points to determine whether the process is in a state of control or not.
i) If the process is judged to be in a state of control, continue doing the work in the same manner.
j) If the process is judged not to be in a state of control, ascertain the cause of the abnormality and take radical measures to ensure that an abnormality is never again triggered by the same cause.
k) After implementing measures to prevent recurrence, check the process.

4. Important Points in the Use of Control Charts

4.1 Control Characteristics (Control Items)

Control characteristics, also called control items, must be such that looking at their values makes it possible to determine whether the process is in a favorable state or not. Therefore, control characteristics must be selected with proper attention. JIS-Z-9021 (control charts) states that characteristics to control should be selected with the following in mind.

a) Thoroughly determine which quality characteristic of the product is the user's required quality, then select characteristics that are importantly related to the objective of use.
b) In addition to quality characteristics of the final product, quality characteristics of raw materials and semifinished products are sometimes selected as control characteristics in accordance with rational requirements of the succeeding process.
c) Although it is acceptable to select characteristics of a machine after assembly, it is often more effective to control each process by selecting, whenever possible, quality characteristics and manufacturing conditions in earlier processes.
d) Sometimes there is only one product characteristic to control, but in many cases two or more must be selected.
e) The characteristics to control that are selected should be ones that are easy to measure and easy to respond to in the process. However, an easy-to-measure characteristic should not be selected unless it is important to quality.
f) When it is technically and economically unfeasible to measure a quality characteristic directly, select the quality characteristics or manufacturing conditions that are closely related to that quality characteristic.
For instance, if the concentration of sulfur is selected as a quality characteristic, the relationship between sulfur's concentration and specific gravity is sufficiently known to permit the selection of specific gravity, which is easier to measure, instead of the direct chemical measurement of concentration.

g) Characteristics related to output can be selected as characteristics to control. Yield, unit and production, for instance, can be controlled with control charts.

What is important here is to determine the proper control characteristics. In actuality, however, this is a difficult task that requires persistent research and investigation.

There are various methods of determining the proper control characteristics: for instance, using existing characteristic charts; using functional expansion or quality expansion; or using defective factor system charts, which Matsushita Electrical Components Co. has used with success. It is important to first of all to ensure that the control characteristics selected are free from omission, and that they agree with consumers' required quality. Next, those control characteristics that are truly important, and those with a high rate of contribution, are selected from among these tentatively chosen control characteristics and incorporated into the control charts to use in control. Consequently, Pareto diagram analysis (for instance) is required. If the control characteristics thus selected prove unsuitable (i.e., their measurement is too time-consuming), then substitute characteristics can be selected by performing correlation and reversion analysis, etc.

Finally, it is important that quality characteristics be reexamined and revised regularly and when the process undergoes change, for instance.

4.2 Stratification

Stratification must be performed whenever possible in order to use control charts effectively. Skillful stratification makes it possible to ascertain causes quickly and implement countermeasures speedily when an abnormality occurs.

However, stratification requires the clarification of the history of how the product in question was made — for instance, the materials used, the time of their arrival, who processed them, with what equipment and under what conditions. Thus, the process must be implemented with stratification — for example, attaching process history cards for each lot and entering the work conditions and quality conditions.

Because stratification generally affects cost, the following must be kept in mind.

a) Stratification is closely related to technology and must be carried out according to technological realities.

b) Stratify the process broadly at first, then, when problems appear, stratify specific areas. This requires that data histories be closely investigated.

c) The consolidation of strata, etc., may be considered once, after stratified control is implemented, the process stabilizes and potential problems are eliminated.

Control diagrams of fractions defective must be used to pay particular attention to details concerning defects. This is because a given defective product may contain only one defect or three; the details of defects are always different. Consequently, defective products must be stratified by types of defect, such as scratches and cracks.

4.3 Grouping

Grouping is the process whereby groups are formed in such a way that dispersion within a given group is from chance causes only and dispersion between two given groups is from abnormal causes.

Because the intent is to make each group as internally uniform as possible, and to ensure only significant dispersion among groups, it is necessary to prepare for grouping by first considering the objectives of the control charts: what type of dispersion is to be controlled, and how to get that dispersion to appear as intergroup dispersion. This requires sufficient stratification prior to grouping and technical investigation to determine what dispersion both within and among groups will signify. There are several possible ways to group, and so the components of intragroup variation (i.e., the factors contained in dispersion) must be investigated.

In the grouping in Table 1, for instance, the dotted squares indicate groups. Let us investigate the components of intragroup dispersion. (Numbers represent data obtained.)

Table 1

Equipment		No. I		No. II	
Worker		A	B	C	D
March 1	Morning	47, 32	44, 35	20, 19	37, 31
	Afternoon	25, 34	19, 11	16, 11	44, 29
March 2	Morning	28, 12	45, 36	25, 28	40, 35
	Afternoon	35, 41	27, 37	[illegible], 45	28, 44

1) March 1

In this grouping of sets of data for each worker, obtained in the morning and afternoon, intragroup variation represents morning and afternoon variation in each worker and machine, sampling error and variation in measurement, while intergroup variation represents variation between workers, variation between morning and afternoon, daily variation and variation between machines. Thus, all variation not contained in intragroup variation is contained in intergroup variation.

2) March 2

Here, morning data and afternoon data are grouped together for each worker. Intragroup variation therefore includes one-day variation (i.e., between morning and afternoon) for each worker and machine, along with sampling error and measuring error. Thus, the type of intragroup variation recorded depends on the method of grouping.

However, it must be noted that the relationship between intragroup variation and intergroup variation is a relative one. Professor Oba of the Science University of Tokyo likens this relationship to a bar of "yokan" (sweetened and jellied bean paste): When the right half is cut big, the left half will be small, and when the left half is cut big, the right half will be small. Similarly, the sum of all variation is always the same, no matter how intragroup and intergroup variation is calculated, and so intragroup variation will increase and decrease according to the method of grouping used. It is therefore important, when grouping, to technically research the content of intragroup and intergroup variation so that they agree with technical knowledge.

Generally, a single cause — usually a chance cause — is responsible for dispersion in the quality characteristics of products produced by a given worker with the same machine over a short period of time, and so, barring special reasons, groups may be created by dividing chronologically at equal intervals.

If, however, standards (such as quality standards) have been rationally set and process dispersion is extremely low, grouping too uniformly can sometimes result in more points falling outside the limits, causing work to be performed more strictly than necessary and thereby being uneconomical. Therefore, grouping should be done in such as way as to result in the greatest amount of intragroup dispersion allowed, particularly in the case of process control. Groups formed in this manner are called rational subgroups.

4.4 Group Size

Group size is determined by taking into account such implementation-related issues as ease of sampling, the economics of measuring and ease of on-site calculations, as well as power of test with respect to process variation.

In control chart $\bar{x}$-R, group size n should be larger in order to better detect process variation. From the viewpoint of accurately estimating intragroup dispersion, n should not be too large, as this would lower the efficiency of range R.. Normally n is set between 2 and 5, sometimes between 2 and 10.

In the case of control charts for enumerated data, it must be remembered that the width of control limits is set according to sampling error, and so varies according to group size. For instance, control chart P can be expected to be in a state of control, regardless of group size, as long as the manufacturing process's fraction defect is constant in the strict sense. In actual manufacturing processes, however, the fraction defective changes constantly, and so group size should be decided after determining roughly what degree of process variation should be detected, and at what rate it should be detected. This is done by first drawing a control chart to determine whether there is considerable dispersion in the points or not. If point dispersion is considerable, group size should be small — for instance, a half-day if group size had been one day, or two hours if group size had been a half-day. If point dispersion persists, a sample of points, rather than all points, should be used as the group size.

If, say, 500 units are produced in two hours, and a group size of 500 results in considerable dispersion, 200 of the 500 units produced could be sampled randomly, for a group size of 200. In other words, data should sometimes be disposed of when points are too dispersed. A group size thus arrived at should be used if it makes it possible to achieve the original goals and results in a usable control chart.

Dr. Juran proposes that minimum group size be arrived at using a sample size large enough to indicate that results are significantly better than standard when the group is free of defects (i.e., defective products). Consequently, he says, the sample size n should be larger than $(9-9\bar{p})/\bar{p}$.

4.5 The Method of Sampling

It must be remembered that the method of sampling affects the significance of grouping, particularly the significance of intragroup variation. For instance, the random sampling of four units over two hours (method A) would result in different technical significance for intragroup variation than would the sampling of four consecutive units in a two-hour period (method B), even though group size is $n = 4$ in both cases. Moreover, method B would result in lower intragroup variation and therefore overlook large amounts of information concerning the time period sampled (Fig. 1).

Random sampling is the general rule in process control, and so method A would be the preferred method of sampling. Actual sampling can be performed during movement, or sampling cards, etc., can be used.

(A) | o o o o | o   o o o | o o o o | o o   o o |

(B) | oooo | o ooo | oooo | oooo |

Fig. 1

4.6 Determining and Revising Control Lines

The general rule regarding control lines in control charts for process control is to extend them when the control chart is found to be in a state of control after process analysis. The reason is that if process analysis indicates a state of control, continuing to control in the same manner should result in the control characteristics falling within those limits. Another reason is that when points fall outside the limits, it can be concluded that some sort of abnormality has occurred in the process, in which case not just statistical reexamination but also a comparison of standard and target values and examination of the progress of standardization and technical factors are necessary.

A control line may be statistically extended when

a) at least 25 consecutive points fall within the control limits;
b) no more than one of 35 consecutive points falls outside the control limits; and
c) no more than two of 100 consecutive points falls outside the control limits.

A control line thus determined is revised (i.e., recalculated) when

a) there are major changes in the four M's (Man, Machine, Material and Method), which are the conditions of production;
b) control charts show that the process has obviously changed; or
c) no process changes have occurred, but a certain amount of time (e.g., three months) has passed since the control chart went into use.

4.7 Taking Action

In process control based on control charts, appropriate action must be taken regarding the process when points fall outside the limits, as this indicates a process abnormality.

Types of action regarding a process include emergency measures and measures to prevent recurrence; of the latter type there are recurrence prevention measures that can be implemented immediately and those that cannot.

A recurrence prevention measure entails ascertaining and eliminating the cause in order to stabilize the process, and taking radical action to prevent abnormalities from ever arising from the same cause again. This is an important tool for stabilizing the process and raising process capacity.

It must be remembered, however, that some recurrence prevention measures are radical measures that cannot be implemented by one's division and instead require the cooperation of other divisions, while others require budgetary allocations (for equipment renovation, etc.). In fact, companies sometimes postpone taking action for these reasons. However, such measures should be implemented concurrently with the type of recurrence prevention measures, such as the revision of work standards and worker education, that can be immediately implemented by a single division.

When implementing a recurrence prevention measure, the cause must first be ascertained. One method of doing so can be seen at Toyota Motor Corporation, which asks a series of five "Why's" for each phenomena. For instance, if a machine stops working, it asks, "Why did the machine stop?"; in response to the reply, "Because an overload caused the fuse to blow," it asks, "Why did the overload occur?" and so on. Through this series of five "Why's," the company strives to ascertain the cause of a problem. Toyota reports that failure to implement this method properly prevents the true cause from being ascertained, in which the same problem will recur some months later.

Systematization is also necessary to ascertain causes. Sekisui Chemicals Co., Ltd., has achieved solid results by establishing a control chart abnormality investigation committee, while Kyushu Nihon Denki Co., Ltd., has had success with QC teams (comprised of staff members) that are sent to correct abnormalities encountered by work site supervisors. Other firms have been successful by designating the ascertaining of causes as an action theme of QC circles.

Nonetheless, it is very difficult to ascertain the true cause of an abnormality. When the true cause cannot be ascertained, the remark "Cause unknown/Under investigation" should be written on the control chart. At one company, 80% of points outside limits were listed as "Cause unknown" when control charts were first introduced, but today nearly all causes are found, resulting in indications of the causes of and countermeasures for points falling outside the limits, which has stabilized processes and improved process capacity.

Mr. Kamikubo at Tokai Chemical Industry Co., Ltd., warns that being too specific or demanding concerning annotations for points outside limits can prompt staff members to write false information when the cause is unclear. He adds that the first action to be taken when an abnormality occurs is to stop production. Stopping production, he says, compels all related personnel to assemble and enables them to focus on eliminating the cause of the abnormality, which in many cases allows for unexpectedly quick resolution.

Emergency measures are measures to eliminate the phenomena, and include measures concerning the process, such as equipment and work methods; and measures concerning the product, such as reprocessing, selection, alteration and readjustment. Such measure should be thought of as temporary measures implemented before recurrence prevention measures can be taken, and must be designed to unfailingly prevent recurrence.

When points fall outside the limits, it is also important in terms of quality assurance to identify the affected lots and to report the abnormality to related processes.

A process abnormality is generally reported with a process abnormality report, which is used to rapidly report the details of the process abnormality, to check whether correct measures have been taken, and to promote and control recurrence prevention measures. It is therefore necessary to define who is to fill in the report, when and how to fill it in, where it is to be issued, the report's route and the procedure for ledger control.

4.8 Checking Whether Control Charts Are Being Skillfully Used in Process Control

In order to ensure that control charts are used skillfully in process control, an investigation to determine the following should be performed once every six months or one year.

a) Are the control characteristics the appropriate ones? Do they need to be changed?
b) Is the method of control chart selection the appropriate one?
c) Are grouping and stratification appropriate? Is further division or consolidation necessary?
d) Are the group size, sampling method and measurement methods the appropriate ones?
e) Are the appropriate control standards being used for control chart use?
f) Have control lines been reexamined?
g) Are the causes of points outside the limits being ascertained properly, and are the appropriate measures to them being taken?
h) Are the results of measures unmistakably improving?
i) Should control charts be continued as they are?

V. Process Assessment

1. Assessing Process Control

1.1 Objectives in Assessing Process Control

The objectives of process control assessment are preventing problems affecting process control; comprehensively assessing inter-division problems; and determining a direction for solutions. It also entails investigations, assessment, authorization, warnings and advice, for instance, concerning the structure and achievements of process control.

The aspect of structure encompasses the drafting of process control plans, implementation of abnormality processing and recurrence prevention measures, standardization and change control, for instance.

Process control implementation deals with control levels, the state of control, the frequency of abnormalities, and process down time due to the causes of abnormalities.

Once the process is shown to be in a state of control, the methods of grouping, stratification and the revision and abolition of control characteristics and control charts themselves should be examined, along with the status of revisions in group size and sampling intervals, etc., with the results applied to the replanning of process control.

1.1 The Flow of Process Control Assessment

1) Selecting the Processes to Be Assessed

When frequent complaints are made or the process is changed, or when the overall state of process control must be known, the process in question is assessed.

2) Forming an Assessment Team

An assessment team is comprised of supervisors primarily from the quality assurance division but also from the divisions responsible for process selection and work organizing.

3) The Implementation Procedure

Assessment plan:

A plan is drafted covering the selection of relevant processes, assessment team formation, examination of the methods of assessment, and preparing the documentation that will be needed during post-implementation meetings and inspections.

Assessment:

This involves investigations of structure and achievements and checklist-based assessment. Knowledge and experience concerning optimum process conditions and standards is actively utilized to avoid overlooking subtle differences in phenomena.

Preparing assessment reports:

This report should focus on facts. Ideally, rather than merely pointing out good and bad points, results are related to product names, part names, process names and element work names, etc.; phenomena are objectively identified; individual knowledge, capability and experience are put to use in order to ascertain the cause and devise countermeasures capable of maintaining the process in a state of control; and terms understandable to those involved are used.

Using the results of assessment:

The assessment report is presented to the process supervisors, who then inform the assessment team of the promotion plan for each item. The appropriateness and status of these plans are checked, and reports on whether the process is in a state of control are received.

4) Innovations in Assessment

There are mistakes common to cases of assessment that failed.

— Process Mistakes —

- Failing to understanding the objectives of assessment by presenting only favorable aspects
- Hiding unfavorable aspects
- A lack of process orderliness, neatness and proper environmental conditions (These and other factors greatly affect quality, and so proper steps should be taken in preparation for the day of assessment.)
- A lack of consistency in documentation and explanations
- Failure to apply the results of assessment in an organized manner

— Mistakes made by assessment teams —

- Inadequate studying of the process
- An absence of trust between team members and process personnel
- Engaging in mere faultfinding without looking at the positive aspects, thereby impeding independent control activity
- Failure to define points of emphasis
- Failure to run through the circle of control during assessment.

Innovation to prevent these mistakes from being made are therefore necessary.

1.3 Preparations for Undergoing Process Assessment

Process-related information should be organized in order to ensure that the facts are judged impartially within a limited amount of time. It goes without saying that data sheets that concern quality, as well as control charts, and standard sheets and other documents used in daily operations, should be prepared so they can be presented immediately when needed. Recent cases explaining the structure and administration of process control should be presented in order to enhance both sides' awareness of problems.

Emphasis in assessment is placed on determining, for instance, whether countermeasures and solutions to problems faithfully comply with predetermined systems, standard sheets and manuals; whether a problem that wasn't solved would have been detected quickly (or in the pre-process) had the system been followed; and whether it would have been impossible to forecast the problem even if the system had been complied with because of deficiencies in the system, in the flow of information from related divisions or in checks at each step, or because of extensive deficiencies among divisions. Documents that answer these questions must therefore be prepared. These include the following.

Fact reports
QC process charts
Process abnormality reports
Quality assurance system diagrams
Standards and results concerning equipment maintenance and inspections, etc.

1.4 Key Points Concerning Checklists

Before assessment, checklists are prepared in order to facilitate comprehensive assessment and prevent omissions in assessment. Below are key points to be kept in mind when preparing checklists.

1. Arrange items so that they can be checked in the same sequence as in the process flow.
2. Select items that will facilitate the totaling, summarization and organization of results.
3. To assess objectively, use numeric assessment by assigning assessment points.
4. An all-encompassing assessment produces superficial results that are insufficiently compelling to prompt improvement or serve as a warning. Instead, focus on important items and investigate key areas exhaustively.

1.5 Points to Check in the Assessment of Process Control

Two technological aspects the assessment of process control are control technology and the intrinsic technology of the process in question. Depending on intrinsic technology, process achievements and other factors, the setting and maintaining of optimum conditions are included in the scope of the later aspect of assessment. As the succeeding section deals with the assessment items that should be checked according to process characteristics, those related to quality control are presented here.

1. Whether the control items defined for process control are appropriate, and how they have been revised or eliminated
2. The methods of stratification, grouping and lot control
3. Samping time intervals and sample sizes
4. Abnormality measures and recurrence prevention measures
5. Workers' awareness of quality
6. Foolproofing
7. The process's state of control and control level
8. The frequency of and intervals between abnormalities
9. The time required to return the process to normal after an abnormality occurs
10. The appropriateness and speediness of quality information
11. How thorough changes or revisions in standards are implemented
12. Financial loss and time lost due to process abnormalities
13. Originality and innovation used to achieve process control plans
14. Originality and innovation in applying work standards
15. Harmonization in the documents presented

2. Viewpoints in Assessments in the Assembly Industry

Other references should be referred to other for general rules, which are omitted here. Below is an enumeration of viewpoints that focuses on the characteristics of the assembly industry.

1) A characteristic of the assembly industry is that defective products can be repaired. Consequently, defective products, depending on the nature of their defects, are sometimes repaired by workers in the next process, who then neglect to report these defects. Workers in the wiring process, for instance, may correct a mistake made in the preceding process as it would prevent them from doing their job. In an automatic soldering process for printed circuit boards, there is sometimes a "repair process," in which products are assumed to have defects and mechanically repaired.
   This does not prevent recurrence: Repairs are not always included in the defect count, reported or recorded.

2) The quality of assembled products is greatly affec i by the quality of their parts.
   Certain types of part defects uncovered in the ass mbly process necessitate the complete replacement of that part in the entire lot. Check whether affected parts were replaced only in defective products.
   Make sure that investigation of a defect encompasses not just the fraction defective but also the qualitative severity of the defect.
   In part because of concerns about output and delivery schedules, this type of problem, more than any other, calls into account a production supervisor's awareness of quality.
   For example, in the case of electronics, correlations among lots are often observed between the market fractions defective due to component quality, and fractions defective in the production process.
   Although efforts are made to use failure analysis to prevent part defects in the acceptance stage, new phenomena and problems are detected daily, while such efforts cannot prevent quality changes due to process changes made by a parts manufacturer.
   Consequently, such changes often manifest themselves first as changes in the fraction defective in the process. When control focuses only on the level of fraction defective, a defect can be hidden among other defects, and so it is necessary to verify that the process has been stratified, and to determine whether the defect in question is limited to the single defective product detected or is a fundamental problem with considerable dispersion that has merely manifested itself as the defect. If this cannot be determined, either all parts must be replaced, or defects in the market must be expected.
   Examples of such cases include semiconductors (baking was possible but not screening), switches, condensers, parts containing lubricant and parts with press-fit caulking connections.

3) Determine the reasons for an absence of the predetermined type and number of components needed in assembly.
   (1) Stop the processes until all types and numbers of components are in place.
   (2) Continue processes that can be continued, or continue until the maximum number of units possible are produced.

   For some reason, the rate of defects seems to increase in the remaining processes or among the remaining number of units in such cases. Ascertain what type of countermeasures have been taken.

4) In the assembly industry, there is an "adjustment process."
   Despite the term "adjustment process," in actuality a major of mandays in this process are devoted to repairs.
   When a defect is left for the adjustment process, ascertaining the cause is time-consuming and requires considerable skill and experience. In addition, products examined and tinkered with during the repair process are never better than — and often worse than — products that required no repairs.
   One of the most serious problems is the delay in feedback. The adjustment process can be judged by the number of mandays, i.e., whether mandays are appropriate for mere adjustment work (such as turning trimmer dials and VR's or adjusting gauges) and whether dispersion in mandays per unit is large or not.
   Another indicator is whether adjustment mandays are in a state of control or not. This is an important point to check, as it reflects the effectiveness of daily process control — i.e., how far back countermeasures are being controlled.

5) Aging is performed during block assembly and after the completion of assembly.
   (1) Although measurement and inspection are often performed after a certain amount of aging, nonconformities that occur during aging sometimes seem as if they have been rectified.

This is because of essentially unstable quality, in which case it must be determined whether intermediate records are being kept.
Example: Switches and certain semiconductors

(2) The predetermined amount of aging is sometimes not performed on products that are repaired after a defect was discovered during aging.
Note: Aging specifications themselves are not examined.

6) When manual repairs are performed off the production line, repaired products are sometimes sent to the process following the one where the defect was discovered. Instead, the product should be sent back to the beginning of the original process.

The assembly industry is broad in scope, making it impossible to cover all items. Rather than check sheets in which items are listed then selected and omitted as seen fit, resulting in ambiguous checking of progress, we have proposed those priority points we feel require attention. Hopefully, each corporation will understand their intentions and create check sheets suited to their own operations.

3. Points for Inspections in Processing Processes

Of the various processing processes, cutting, heat treatment and welding are discussed below.

3.1 Cutting

1) In cutting, some products have several thousand parts and characteristic values to which control applies, and so instead of trying to control them all, those parts and characteristics that significantly affect the product's functions must be defined and controlled. Here the question is, Is the method for selecting these parts and characteristics defined?
2) Are there criteria for properly processing the defined parts and characteristic values? Have the drawings, standards, specifications and work standards, etc., been revised?
3) Have the factors that greatly affect characteristics been defined for each cutting process? How are these factors checked and kept under control? Are there QC process drawings (i.e., QC process control tables and process assurance item tables) that define methods?
4) Are important characteristics defined in these QC process drawings, and is control based on control drawings?
   (1) Are sampling times, intervals and "n" to be entered on control drawings defined in a way conducive to detection of factor variation?
   (2) Are the causes of abnormal points adequately investigated, and are recurrence prevention measures also implemented?
   (3) Are control drawings written so that the system of factors will be understandable at a later date (e.g., by process, by machine, by work, by material and by shift)?
5) Is the storage space for defective products defined? Are defective products processed properly? Are the causes of defects investigated, and are recurrence prevention measures carried out properly?
6) Do workers receive technical training? Is this training evaluated? Are records of the training kept? When the cause of a defect or abnormality turns out to be a worker, is this cause incorporated into the next technical training schedule?

3.2 Heat Treatment

1) Are the right materials being used? Are the proper shortcut methods for material identification and storage space indication and marking used to keep out contaminants?
2) As it is impossible to tell visually whether heat treatment has been completed, and because repairs are not possible, process control is the only way to assure proper heat treatment. Are the proper heat treatment conditions indicated in order to ascertain factors?
   (1) Is furnace temperature distribution checked according to directions?
   (2) Is an effective zone designated for each furnace?
   (3) Does charging weight suit furnace capacity? Are the style of packing and arrangement during charging defined? Are they being complied with?
   (4) Are heating time and temperature and cooling temperature and time properly recorded?
   (5) Are temperature-measuring instruments inspected regularly? Are separate thermometers used for measurements and records?

3) Coil precision affects the depth of induction hardening. Are coils controlled properly?
4) Are penetrometers inspected and their period of effectiveness designated? Is this being complied with?
5) When prototypes are heat-treated, are the conditions properly recorded and used as feedback when setting the heat treatment conditions for mass production?
6) Are the locations of storage spaces within the work site defined and properly controlled to keep intermediate products, uncompleted products and heat-treated products separate? In particular, is storage space for defective products clearly indicated?

3.3 Welding

1) Precision in the dimensions of materials greatly affects the amount of distortion. Is the precision of material cutting controlled? Joint geometry and dimensional dispersion have a particularly considerable effect on the quality of welding output. Is the process controlled to keep this dispersion within certain limits?
2) Are procedures that always result in deformation properly defined, and is welding work performed accordingly?
3) Are the work procedures (i.e., temporary welding and final welding) that minimize deformation defined, and is welding performed according to these procedures?
4) Are the procedures in which first products and prototypes, along with other data, recorded? Are these records applied to the work methods for mass production processes?
5) Because a majority of welding work can be repaired in the event inspection reveals a defect, repair work tends to be confused with normal work. Are the two clearly distinguished?
6) Welding conditions (i.e., amperes, voltage and speed) affect welding output. Are they correctly set?
7) Storage control (dryness) for welding rods greatly affects output. Is control adequate?
8) Some materials can cause weld cracks. Are preheating and postheating defined and carried out correctly?
9) In welding, complete weld penetration is important to assure proper penetration. Are the methods for checking weld penetration defined? Is weld penetration checked according to these methods? Are the methods and intervals of checking and criteria defined?

4. Checklists for Process Assessment for High-Quality, High-Quality Products

NASA-NHB 5300/4 (1B) and other quality programs define common general requirements used to assure the high quality required by aeronautic and space systems. To actualize such a program, it is essential that design , development control, manufacturing control, purchasing control, inspection and testing, for instance, be unfailingly implemented. In particular, manufacturing process where material uniformity and high quality cannot be assured with inspection alone must be controlled. Such processes, referred to as special processes, include metallurgical and chemical processes and metallic bond, adhesion, plating, coating and surface treatment processes; these must be emphasized in control. Below are checklists for process assessment that include these processes.

4.1 Quality Assurance Activities

1) Do they suit the quality control structure? Do they comply with quality program plans?
2) Are there central experienced inspection and testing personnel in the manufacturing division?
3) Are there established acceptance inspection rules for materials and parts?
4) Are there established control rules for nonconformities relating to the technical conditions of manufacturing, inspection and testing?
5) Are drawings, specification sheets and technical documents stored properly?
6) Are measures to minimize process defects implemented effectively?
7) Are all gauges and other inspection tools, as well as testing devices, inspected regularly?

4.2 Process Inspection

1) Are the methods used in inspection sampling rational? In other words, do they permit the quick detection of changes in process quality?
2) Are adequate measures taken to prevent parts and materials from contamination, dirtying, damage and rusting?
3) Are questionable or nonconforming sub-lots sorted out for inspection or other measures?

4.3 Drawing and Technical Change Control

1) Are current versions of applicable drawings distributed according to control methods that assure that they will be used effectively, at the proper time and at the proper location during inspection?
2) Are discontinued drawings previously used in manufacturing or inspection exchanged or returned according to the procedure stipulated by the owner?
3) Are records of technical changes kept so that they can be examined by the owner at any time?
4) Do personnel in charge of production or inspection refrain from using drawings to which unauthorized changes were made (say, in pencil)?
5) When a technical change has been made in accordance with a contractual change, can it be assured that the change was actually implemented within the prescribed amount of time?

4.4 Inspection Instruments and Testing Devices

1) Is the precision of all jigs and tools used in inspection checked before use?
2) Are all jigs, fittings and other assembly devices regularly maintained according to the procedure stipulated by the owner?
3) Can applicable drawings, specifications and other technical data be readily used in tool and jig control?
4) Are all tools and jigs protected from damage during use, transport and storage?
5) Are all tools and jigs that are out of operation or no longer used kept separate from current tools and jigs?

4.5 Special Processes

4.5.1 Resistance Welding

1) Have all welders passed inspection?
2) Is the welding schedule set?
3) Are physical and metallurgic tests carried out regularly as required?
4) Do machine settings comply with authorized welding schedules?
5) Are the cleaning procedure and processing of waste water appropriate?
6) Are proper inspection records kept?
7) Are electrodes in proper condition?

4.5.2 Melting Welding

1) Have all welding personnel passed inspection?
2) Are records of welding personnel's performance maintained?
3) What about the standards for passing and failing?
4) Do the welding rods used in production comply with the applicable requirements?

4.5.3 Electroplating

1) Are parts completely cleaned prior to electroplating?
2) Is equipment controlled effectively?
3) Are the temperature and concentration of plating fluid inspected regularly as specified?
4) Is stress relief performed on all springs and intensity parts?
5) Are adequate records kept of plating fluid analysis, thickness testing, salt spray testing and adherence tests?

4.5.4 Heat Treatment

1) Have heat treatment equipment and procedures been certified?
2) Are temperature controllers calibrated regularly as stipulated?
3) Are proper heat treatment and testing instructions readily available to personnel?
4) Are furnace temperature distribution tests performed as required?

4.5.5 Potting and Molding

1) Is an appropriate potting procedure used?
2) Have chemical materials passed acceptance inspection?
3) Are chemical materials stored appropriately?
4) Are materials identified as those specified on process specification sheets and manufacturing drawings?
5) Are workers certified? Have they received training on chemical materials, even ones outside the range of certification?

5. Purchasers' Inspections of Suppliers

The part of section 4 that concerns inspections for high-quality, high-reliability products concerns the purchaser requirements that the supplier must comply with — and also applies to suppliers (from the purchaser's point of view, the contractor) when performing an internal inspection, or when inspecting a subcontractor.
Here, two firms, Nippon Telephone and Telegraph Public Corporation (NTT) and Japan National Railways, are presented as an example of a purchaser's inspections of suppliers. These examples should serve as a reference not only for internal inspections, but also for quality control inspections of cooperating companies' process control, for instance.
It must be added that a supplier must strive not just to satisfy the purchaser's requirements, but also to establish methods for internal inspection.

5.1 Assessment at the Japan Telephone and Telegraph Public Company

5.1.1 Introduction

Below are the types of assessments that a purchaser generally carries out of a supplier (factories and plants, etc.).

(1) Assessment of suppliers providing goods and other products This type of assessment, performed prior to a supplier's selection, covers the supplier's management, technology and quality control, etc.

(2) Assessment to rationalize and increase the efficiency of purchasing inspection
This type of assessment, which is used when shifting to reduced purchasing inspection (for instance, when adopting a no-inspection system), is used to determine, when the results of product inspection indicate that product quality is good, whether or not the current system is capable of continuing to produce products of good quality.

(3) Assessment to determine whether product quality and quality assurance have been maintained or improved.
This type of assessment is used to determine whether the quality of products that have been approved for a no-inspection system, for example, is stable, and whether the quality assurance system is being maintained.

Here, types (2) and (3) above implemented by the inspection division of the Japan Telephone and Telegraph Public Company (referred to below simply as "NTT") are dicussed.

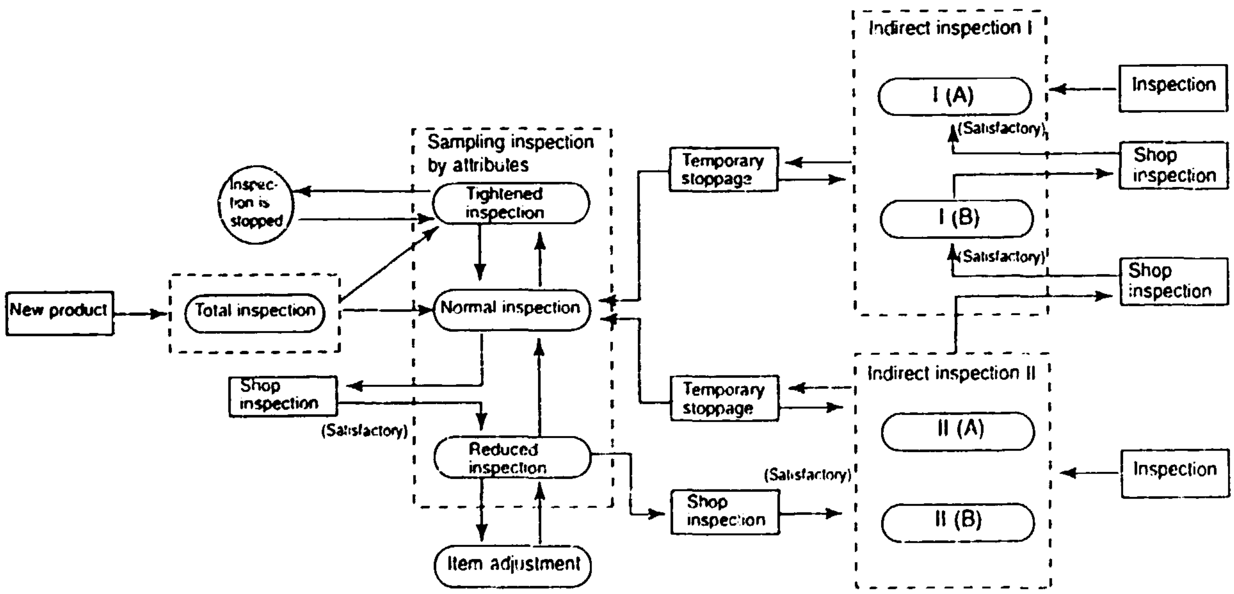


Fig. 1 The flow of each type of inspection

5.1.2 Purchasing Inspection at NTT

There are two types of purchasing inspection at NTT: direct inspection and indirect inspection. Direct inspection involves sending NTT personnel (inspectors) to a supplier's factory to test products and decide whether they pass or fail inspection. In indirect inspection, instead of NTT directly performing inspection, a supplier is requested to send data on the results of internal inspection; these data are used to decide whether a product passes or fails inspection. In direct inspection, total (100%) inspection and sampling inspection by attributes (MIL-STD-105 D) are used.

The flow of inspection (Fig. 1) is as follows: First, total inspection is performed on all lots of new products and the products of new suppliers, after which the company switches to sampling inspection by attributes. In sampling inspection by attributes, severity is adjusted, and if quality if good, the company then shifts to indirect inspection.

5.1.3 Assessment to Rationalize and Increase the Efficiency of Purchasing Inspection

When the results of inspection are good and NTT concludes that the supplier in question is capable of at least maintaining the current level of quality, reduced purchase inspection is adopted. Prior to this shift, a type of assessment called "shop inspection" is performed to determine whether the supplier is capable of at least maintaining the current level of quality.

<Shop Inspection>

In performing a shop inspection, the supplier is first required to submit a document called a shop protocol, which contains the following items.

A. Overview of the company

B. Organization

C. Quality-related conferences and committees (including QC circles)

D. Quality assurance
   The history of quality assurance activity
   Quality assurance system diagrams
   Quality policies and the control thereof
   Education and training on quality control
   The collection and application of market quality information
   A summary of reliability tests that have been implemented
   Characteristics of the company's quality assurance activity

E. Standardization
   The system of standardization
   The procedures for adopting and revising standards
   A summary of the adoption and revision of standards
   Characteristics of the company's standardization activity

F Process control
   QC process drawings
   A summary of process abnormality processing and special adoption
   Characteristics of the company's process control activities

G. Production progress control
   Production progress control
   Characteristics of the company's production progress control

H. Control of accepted products
   The system for the control of accepted products (i.e., purchases and outside orders)
   A summary of acceptance inspections being used
   A summary of guidance provided to suppliers
   Characteristics of the company's accepted products control

I. Control of instruments and manufacturing equipment
   The system for the control of instruments and manufacturing equipment
   Characteristics of that company's control of instruments and manufacturing equipment

J. Packaging, storage and transport
   Locations of packaging plants and product warehouses
   Primary means of transporting goods to points of delivery
   Characteristics of the company's packaging, storage and transport

Table 1

Scoring standards	Very good	Good	Normal	Bad	Very bad
Points	+2	+1	0	−1	−2

- Assessment
  - Normal assessment
    - Total assessment
    - Individual assessment
  - Special assessment

Fig. 2 Types of assessments

Investigation is performed by groups of three or four personnel according to the submitted shop protocol, with assessment points assigned to each of roughly 40 items using the 5-point method (Table 1).
After subtracting any negative points from the combined assessment points for each item to arrive at a total score, the supplier is judged either "Satisfactory," "Unsatisfactory" or "Probation." A supplier placed on probation (a system adopted to encourage suppliers to strive for improvements) receives a list of required improvements. Three to six months later, a second investigation is held, upon which the supplier is designated "Satisfactory" if the required improvements have been made and "Unsatisfactory" if they have not.

5.1.4 Inspections to Determine Whether Product Quality and the Quality Assurance System Have Been Maintained or Improved

At NTT, an "assessment" is an investigation performed when a major quality-related problem has occurred, or to determine whether the quality assurance system of a supplier of indirect inspection-approved products has been maintained or raised since the shift to indirect inspection.

(1) Types of Inquiries
Inqiries are broadly divided into regular assessments and special assessments (Fig. 2).
Normal assessments, categorized by objective into total inquires and separate assessments, are performed regularly (as a rule) to examine the state of quality assurance at each supplier and verify that quality assurance is being properly maintained and improved.
Total assessments are carried out as a rule at least once every two years and consist primarily of checks of a supplier's control system for overall quality assurance.
Types of separate assessments include those carried out generally once annually and consisting primarily of product tests and checks of manufacturing processes for relevant products; and those carried out to ascertain the state of affairs after a specification sheet, etc., or production condition affecting product quality is changed.
A special assessment is carried out when a the results of a regular are "unsatisfactory," or when indirect inspection has been suspended because of a major nonconformity at the work site of use.

(2) Methods of Inquiry
Because of its objective, a total assessment is based on the same items as those of a shop inspection. Consequently, shop inspection at a factory may be skipped if a shop inspection has been held there recently.
In order to assure objectivity in assessment, the same methods of assessment as in a shop inspection are used. Unlike shop inspection, however, the categories of "Satisfactory" and "Unsatisfactory" have been supplemented with the category "Conditional acceptance," which corresponds to "Probation" in shop inspection.
Separate inspection consists primarily of checking processes — i.e., checking whether processes are being controlled according to the QC process drawings submitted.
One characteristic of separate assessment is that completed products are tested and unfinished products measured after intermediate inspection in order to compare them with the results of the supplier's intermediate inspection.
Because of the nature of a special assessment, its items are selected according to objectives; there is no particular assessment based on overall scores, etc.

5.1.5 Conclusion

The most important goal in a shop inspection or assessment is correctly assessing the actual state of affairs. Correct assessment, in turn, requires that the abilities of investigators be enhanced, and so various efforts to do so are being made, such as the holding of research conferences and the preparing of guides.
Also, as the objective of shop inspections and inquires should be to encourage proper quality control activities, examination and improvement of the content of investigations is being further promoted in order to prevent quality control activity from becoming perfunctory or mechanical.

LOGISTICS

J U S E

I. MIYAUCHI

COUNSELAR

1. DEFINITION OF "LOGISTICS"

A) LOGISTICS IS UTILIZED AS A MILITARY TERMS, AS

' THE BRANCH OF MILITARY SCIENCE THAT DEALS WITH ALL ASPECTS OF PROCUREMENT, MOV⁻MENT, MAINTENACE, AND DISPOSITION OF SUPPLIES, EQUIPMENT, FACILITIES AND PERSONNEL AND THE PROVISION OF SERVICES ' IN THE readers digest great encyclopedic dictionary.

B) HOWEVER, WHEN CONSIDERING THE PRESENT COMMERCIAL PRODUCTS SITUATION -- SUCH AS SURVIVAL, DOMINANT COMPETITIVITY SUSTENANCE AND CUSTOMER FULL SATISFACTION, WOULD NOT BE ACHIEVED WITHOUT <u>"LOGISTICS"</u>

CONCEPT IMPLEMENTATION FOR DEALING WITH:

-- NATURAL RESOURCES AND ENERGY CONSERVATION PROGRAM

-- COUNTER MEASURE OF HIGHER ENRGY PRICE

-- COUNTER MEASURE FOR WAGE INCREASE ON HUMAN RESOURCES

-- COUNTER MEASURE FOR POOR SKILL AND KNOWLEDGE ON SYSTEM, EQUIPMENT, AND/OR PRODUCT USE, PRODUCTION, SERVICE AND MAINTENANCE BY CUSTOMER AND OPERATORS

-- COUNTER MEASURE FOR SHORTAGE OF MAIATENACE CREWS IN MARKET

-- COUNTER MEASURE FOR SHORTENING OF PRODUCT LIFE-CYCLE BY SWIFT TECHNOLOGICAL INNOVATION

-- COUNTER MEASURE FOR CHANGING SOCIAL CONCEPT FROM 'CAVEAT EMPTOR TO CAVEAT VENDITOR' AGE

-- COUNTER MEASURE FOR SOCIAL/ COMMUNITY CONTRIBUTION DEMANDS

-- COUNTER MEASURE FOR CONSUMERISM UPROARING

-- COUNTER MEASURE FOR CUSTOMERS COST EFFECTIVENESS OR AWARENESS DEMANDS

C) UNDER SUCH CIRCUMSTANCES.

"THE SOCIETY OF LOGISTIC ENGINEERING" IS DEFINED AS ;

"LOGISTICS IS THE ART AND SCIENCE OF MANAGEMNT, ENGINEERING AND TECHNICAL ACTIVITIES CONCERNED WITH REQUIREMENT, DESIGN AND SUPPLYING AND MAIATAINING RESOURCES TO SUPPORT OBJECTIVES PLAN AND OPERATIONS".

IN SHORT.

"LOGISTICS IS THE SCIENCE PLANNING FOR PROVIDING AND APPLYING THE RESOUCES REQUIRED IN A SPECIFIED OPERATIONAL ENVIRONMENT THROUGHOUT ITS LIFE CYCLE".

D) "LOGISTICS" IS

TO MINIMIZE THE COST OF HUMAN-RESOURCES, EQUIPMENT, COMPONENT, SPARE PARTS, OPERATIONAL AND MAINTENACE MANUAL, AND FACLITIES DURING USE AND MAINTENANCE OF SYSTEM PRODUCT, EQUIPMENT, COMMODITY AND/OR FACILITIES, WHILE

TO MAXIMIZE OF EFFECTIVENESS AND EFFICIENCY OF SUCH SYSTEM, PRODUCT

EQUIPMENT, COMMODITY, AND/OR FACILITIES AT UTILIZATION OR OPERATION STAGES.

AT THIS TIME, COST MEANS BASICALLY LIFE CYCLE COST (LCC), WHICH WILL BE EXPLAINED LATER SECTION.

$$\left(\begin{array}{c} \text{COST} \\ \text{EFFECTIVNESS} \end{array} \right)_{max} = \frac{(\text{SYSTEM EFFECTIVNESS})_{max}}{(\text{LIFE CYCLE COST})_{min}}$$

THE ACTIONS ARE USUALLY ACHIEVED THROUGH THE TRADE-OFF PROGRAM BETWEEN TECHNOLOGICAL REQUIREMENT (CUSTOMERS' FUNCTIONAL NEEDS OR DEMANADS AND COST-EFFECTIVENESS (CUSTOMERS' PRICE ORIENETED NEEDS AMD DEMANDS.), WHICH ARE CALLED AS "LOGISTIC ENGINEERING".

2. SYSTEM EFFECTIVENESS

THE SYSTEM EFFECTIVENESS IS ONE OF MAJOR ELEMENTS TO MEASURE THE MISSION FULFILLMENT DEGREE OF A SYSTEM, EQUIPMENT, OR PRODUCT. BY

A) AVAILABILITY

IT IS INDICATED THAT THE DEGREE OF OPERABLE CONDITION AT THE START OF A MISSION WHEN THE MISSION IS CALLED FOR AT AN UNKNOWN RANDOM POINT IN TIME. THIS IS OFTEM CALLED operational readiness. AND A FUNCTION OF OPERATING TIME (RELIABILITY) AND DOWNTIME (MAINTAINABILITY/SUPPORTABILITY.

B) <u>DEPENDABILITY</u>

IT IS INDICATED THAT A DEGREE OF THE SYSTEM OPERATING CONDITION AT ONE OR MORE POINTS DURING MISSION. GIVEN THE SYSTEM CONDITION AT THE START OF THE MISSION, AND DEPENDABILITY IS A FUNCTION OF OPERATING TIME (RELIABILITY) AND DOWN TIME (MAINTAINABILITY/SUPPORTABILITY).

B) <u>SYSTEM PERFORMANCE</u>

IT IS INDICATED THE CAPACITY OF A SYSTEM PERFORMANCE ARE ACCOMPLISHED AS EXPECTED AT THE END OF MISSION COMPLETED: AS SUCH DESTRUCTIVE CAPABILITY OF A WEAPON, AMOUNT OF CARGO DELIVERED BY A TRANSPORTATION SYSTEM, OR ACCURACY OF RADAR, ETC.

SYSTEM EFFECTIVENESS

- availability
  (STATUS BEFORE MISSION)
- dependability
  (STATUS DURING MISSION)
- performance
  (STATUS AFTER MISSION)

2 − 1 AVAILABILITY

A) operational availabity (A_o)

THE PROBABILITY THAT A SYSTEM OR EQUIPMENT, WHEN USED UNDER STATED CONDITIONS IN AN ACTUAL OPERATIOAL ENVIRONMENT, WILL OPERATE SATISFACTORY WHEN CALLED UPON. IT IS STATED

$$A_o = \frac{MTBM}{MTBM + MDT}$$

WHERE: MTBM is mean time between maintenance

MDT is mean maintenace down-time

B) ACHIEVED AVAILABILITY

THE PROBABILITY THAT A SYSTEM OR EQUIPMENT, WHEN USED UNDER STATED CONDITIONS IN AN IDEAL SUPPORT ENVIRONMENT (i.e. available tools, spares manpower, etc) WILL OPERATE SATISFACTORILY AT TIME. ACHIEVED AVAILABILITY

IS MORE DIRECTLY RELATABLE TO THE EARLY DESIGN PROCESS (AS A MEANS OF MEASURING EQUIPMENT RELIABILITY AND MAINTAINABLITY CHARACTERISTICS) AND IS STATED AS:

$$A_a = \frac{MTBM}{MTBM + \overline{M}}$$

WHERE: $\overline{M}$ means mean active mainteance time. this include scheduled and unscheduled mtn

C) INHERENT AVAILABILITY

THE PROBABILITY THAT A SYSTEM OR EQUIPMENT, WHEN USED UNDER STATED CONDITIONS IN AN IDEAL SUPPORT ENVIRONMENT (i. e. AVAILABLE TOOLS, SPARES MANPOWER, ETC) WILL OPERATE SATISFACTORILY AT ANY POINT IN TIME.
IT EXCLUDES PREVENTIVE MAINTENANCE ACTION, LOGISTICS SUPPLY TIME, AND

DOWN TIME AND IT IS STATED AS

$$A_i = \frac{MTBF}{MTBF + \overline{M}ct}$$

WHERE; MTBF MEANS MEAN TIME BETWEEN FAILURE. AND $\overline{M}ct$ MEANS MEAN CORRECTIVE MAINTENACE TIME.

D) AS AFOREMENTIONED, AVAILABILITY IS A MEASURE OF THE DEGREE TO WHICH AN ITEM IS IN THE OPERABLE AND COMMITABLE STATE AT THE START OF MISSION. WHEN THE MISSION IS CALLED FOR AT AN UNKNOWN (RANDOM) POINT IN TIME.

2 - 2 DEPENDABILITY

DEPENDABILITY IS THE PROBABILITY THAT AN EQUIPMENT'S MISSION WILL BE SUCCESSFULLY COMPLETED WITHIN MISSION TIME(t1) PROVIDING A DOWNTIME PER FAILURE NOT EXCEEDING A GIVEN TIME (t 2) WILL NOT ADVERSELY AFFECT THE OVERALL MISSION.
DEPENDABILITY MAY BE FORMULATED AS

$$D = R + M_0 (1 - R)$$

WHERE: R MEANS MISSION RELIABILITY OR THE PROBABILITY THAT THE SYSTEM WILL OPERATE WITHOUT FAILURE FOR THE MISSION TIME (T1)
M_0 MEANS THE OPERATIONAL MAINTAINABILITY OR THE PRO-

BABILITY THAT. WHEN A FAILURE OCCURS. IT WILL BE REPAIRED IN A TIME NOT EX-CEEDING THE ALLOWABLE DOWN TIME (T 2).

2－3 PEEFOEMANCE

A CAPABILITY TO ACHIEVE MISSION OBJECTIVES GIVEN THE CONDITIONS DURING THE MISSION

2－4 RELIABILITY

A PROBABILITY THAT A SYSTEM OR PRODUCT WILL GIVE SATISFACTORY PER-FORMANCE FOR A SPECIFIED PERIOD OF TIME WHEN USED UNDER STATED CONDI-TION. RELIABILITY CAN BE EXPRESSED IN TERMS OF MEAN-TIME-BETWEEN FAIL-URE (MTBF) OR MEAN LIFE.

2 – 5 MAINTAINABILITY

THE PROBABILITY THAT AN ITEM WILL BE RETAINED IN OR RESTORED TO A SPE- FIFIED CONDITION WITHIN A GIVEN PERIOD OF TIME. WHEN MAINTENANCE IS PERFORMED IN ACCORDANCE WTIH PRE- SCRIBED PROCEDURES AND RESOURCES. MAINTAINABILITY CAN BE SPECIFIED. PREDICTED. AND ASSESSED BOTH ON A QUALITATIVE BASIS AND IN TERM OF A COMBINATION OF MAINTENANCE TIMES. SUPPORTABILITY FACTORS. AND PROJECTED MAINTENANCE COST.

A) MTBF : MEAN-TIME-BETWEEN-FAILURE

B) MTBM : MEAN-TIME-BETWEEN-MAINTE- NANCE

C) MTBR ; MEAN--TIME-BETWEEN-REPLACE- MENT

D) MTBR ; MEAN-TIME-BETWEEN-REPAIR

E) $\overline{M}$; MEAN ACTIVE MAINTENANCE TIME

F) $\overline{M}ct$; MEAN CORRECTIVE MAINTENANCE TIME

G) $\overline{M}pt$; MEAN PREVENTIVE MAINTENANCE TIME

H) Mct: MEDIAN CORRECTIVE MAINTE-
NANCE TIME

I) Mpt: MEDIAN PREVENTIVE MAINTE-
NANCE TIME

J) MTTR: GEOMERIC MEAN-TIME-TO-
REPAIR

K) Mmax: MAXIMUM ACTIVE CORRECTIVE MAINTENANCE TIME (USUALLY SPECIFIED AT THE 90th AND 95th % CONFIDENCE LEVEL)

L) MDT: MEAN DOWNTIME (TOTAL TIME DURING WHICH A SYSTEM/EQUI-MENT IS NOT IN CONDITION TO PERFORM ITS INTENDED FUNC-TION)

M) MMH/OH: MAINTENANCE MANHOURS PER EQUIPMENT OPERATING HOUR

N) COST/OH: MAINTENANCE COST PER EQUIPMENT OPERATING HOUR

O) COST/MA: MAINTENACE COST PER MAINTENANCE ACTION

P) TAT: TURN-AROUN-TIME, ELEMENT OF MAINTENANCE TIME NEEDED TO

SERVICE. REPAIRM. AND/OR CHECKOUT AN ITEM RECOMMITMENT

Q) SELF-TEST THROUGHNESS; THE SCOPE AND ACCURACY OF TESTING

R) FAULT ISOLATION ACCURACY; ACCURACY OF EQUIPMENT DIAGNOSTIC ROUTINE IN PERCENT

2-6 MAINTENANCE

ALL ACTIONS NECESSARY FOR RETAINING AN ITEM IN. OR RESTORING IT TO A SERVICEABLE CONDITION. MAINTENANCE INCLUDES SERVICING. REPAIR. REMOVE AND REPLACE. MODIFICATION. INSPECTION. CALIBRATION. OVERHAUL. AND CONDITION VERIFICATION.

2－7 MAINTENANCE CONCEPT

A SERIES OF STATEMENT AND/OR ILLUSTRATIONS DEFINING CRITERIA CO-VERING MAINTENANCE LEVELS OR ECHELON SUPPORT POLICIES, EFFECTIVENESS FACTORS(e.g. MAINTENANCE TIME CON-STRAINTS), AND BASIC LOGISTIC SUPPORT REQUIREMENT.

THE MAINTENANCE CONCEPT IS A RRE-REQUISITE TO SYSTEM/EQUIPMENT DESIGN AND DEVELOPMENT.

2－8 MAINTENANCE LEVEL OR ECHELON

A DIVISION OF MAINTENANCE FUN－CTION／TAKLS.
AS A EXAMPLE, MAINTENANCE LEVELS MAY BE CLASSIFIED AS: LINE MAINTENANCE, ORGANIZATIONAL MAINTENANCE, DEPOT MAINTENANCES: OR
1ST ECHELON, 2ND ECHELON, 3RD ECHELON, ETC.

3. LIFE CYCLE COST

ALL COSTS ASSOCIATED WITH THE SYSTEM LIFE-CYCLE, SUCH AS

- LIFE CYCLE COST
  - PROCUREMENT COST
    - R & D COST
      - planning cost
      - r & d cost
      - production cost
      - production administration cost
    - PRODUCTION COST

- equipment investment cost
- fabrication and assembly cost
- product support planning cost

- SUSTENANCE COST
  - OPERATION COST
    - material/energy cost
    - equipment cost
    - human-resource cost
    - education and training cost

MAINTAINING COST

- maintenance crew cost
- education and training cost
- documentation cost
- spare/repair part cost
- test & inspection equipment cost

PHASE-OUT COST

- RECYCLING COST
- CONDEMNATION COST

4 MISSION SUCCESS BY LOGISTICS WITH RELIABILITY AND MAINTAIN-ABILY TECHNOLOGY

A) AS MENTIONED IN THE PRECEDING, TO DESIGN AND PRODUCE FOR

COST $EFFECTIVENESS_{max}$

SYSTEM $EFFECTIVENESS_{MAX}$ AND

FINALLY OBTAIN

LIFE CYCLE $COST_{min}$

ARE PRESENT CUSTOMER REQUIREMENT THAT IT IS NECESSARY TO CONSIDER

1) HOW TO REDUCE CUSTOMERS PROCUREMENT COST
2) HOW TO REDUCE CUSTOMERS SUSTAINING/OPERATION COST
3) HOW TO SUSTAIN/IMPROVE SYSTEM/EQUIPMENT AVAILABILITY, DEPENDABILITY, AND FUNCTION AND PERFORMANCE

HOWEVER, IF ONLY EACH RESPONSIBLE ORGANIZATIONS ARE INDEPENDENTLY HANDLE SUCH REQUIREMENT, QUITE UNBALLANCED AND UNDESIRABLE SYSTEM/EQUIPMENT ARE CREATED THAT LOGISTIC ENGINEERING BE INSTALLED WITHIN ORGANIZATIONS TO HAVE OTHER ORGANIZATIONS PAY ATTENTION FOR ORGANIZED AND SYSTEMATIC DESIGN, PROTO-TYPE PRODUCTION, TEST, PRODUCTION, SERVICE, MAINTAINING AT OPERATION OR CUSTOMERS HANDS --. SUCH FUNCTION BE CALLED AS

LOGISTIC ENGINEERING

AND ITS FUNCTION IS DEFINED AS

INTEGRATED LOGISTICS SUPPORT

B) INTEGRATED LOGISTICS SUPPORT IS TO FURNISH EVERY PRUDENT SUPPORTING CONSIDERATIONS TO ASSURE ULTIMATE CUSTOMER/CONSUMER/END-USER WILL HAVE NOT ONLY EXPECTED PERFORMANCE/FUNCTION REQUIREMENT, BUT ONE WHICH CAN BE EXPEDITIOULY AND ECONOMICALLY

SUPPORTED ITS INTENED LIFE-CYCLE.

ITS PRINCIPLE ELEMENTS COVERED TO THE OVERALL SYSTEM LIFE-CYCLE --SUCH

* MAINTENANCE PLANNING
* TEST AND SUPPORT EQUIPMENT
* SUPPLY SUPPORT
* TANSPORTATION AND HANDLING
* TECHNICAL DATA
* FACILITIES
* PERSONNEL AND TRAINING
* LOGISTIC SUPPORT RESOURCE FUNDS
* LOGISTIC SUPPORT MANAGEMENT INFORMATION

ITS FUNCTION ARE STARTING FROM

* LOGISTIC SUPPORT ANALYSIS
* LOGISTIC INITIAL PLANNING (SUPPORT CONCEPT PLANNING)
* TEST & SUPPORT EQMT ACQUISITION
* TECHNICAL PUBLICATION
* FUNDING
* MONITORING
* EVALUATIONS
* CORRECTIVE ACTIONS
* RECOMMENDATIONS

C) ILS MEASURING INDEX

ILS HAS OVERALL RESPONSIBILITY FOR SYSTEM EFFECTIVENESS SUSTENANCE AND IMPROVEMENT THAT CONVENTIONAL INDEX -- IN ADDITION OF CONVENTIONAL INDEDXED. RELIABILITY. MAINTAINABILITY AND SAFETY. THE FOLLOWINGS ARE RECOMMENDED TO CONSIDER;

1) MISSION RELIABILITY

-- MISSION COMPLETION SUCCESS PROBABILITY
(MCSP)

-- MEAN MISSION DURATION
(MMD)

-- MEAN TIME BETWEEN CRITICAL FAILURE
(MTBCF)

2) LOGISTIC RELIABILITY (SOMETIMES CALLED AS SUPPORTABILITY)

-- MEAN TIME BETWEEN MAINTENANCE
(MTBM)

-- MEAN TIME BETWEEN REMOVAL
(MTBR)

-- MEAN TIME BETWEEN DEMAND (MTBD)

D) ROLE OF RELIABILITY AND MAINTAINABILITY

1) SYSTEM EFFECTIVENESS ARE ALWAYS CONTROLLED ITS EFFECTIVENESS AS A SYSTEM OR EQUIPMENT. AND EACH CONFIGURED PARTS/COMPONENT/UNIT ARE NOT DISCUSSED TILL NOW.
HOWEVER, SYSTEM EFFECTIVENESS ARE NOT CALCULTED W/OUT SUCH EACH UNIT/PART RELIABILITY AND MAINTAINABILITY values DURING ITS MISSION ACCOMPLISHMENT;

<u>AVAILABILITY</u>

- RELIABILITY (BY PART/UNIT)
- MAINTAINABILITY
- HUMAN FACTORS

<u>DEPENDABILITY</u>

- REPAIRABILITY
- INTERCHANGE-ABILITY
- REPLACEABILITY
- FLEXIBILITY
- SURVIVABILITY

2) LIFE-CYCLE COST

UNDER THE SAME TOKEN, LIFE-CYCLE COST ARE ALSO AFFECTED BY SUCH VARIABLES:

LIFE-CYCLE COST
- PROCUREMENT COST
- OPERATION COST
- PHASE-OUT COST

DESIGN ATTRIBUTE
- INTRINSIC DESIGN
- RELIABILITY
- MAINTAINABILITY
- SAFETY
- HUMAN FACTOR
- PRODUCIBILITY
- ETC

5 RELATIONSHIP BETWEEN DESIGN AND LOGISTICS ENGINEERINGS

A) PRIOR TO EXPALIN A PHYSICAL LOGISTIC WORK. IT MAY BE NECESSARY TO EXPALIN HOW DESIGN ENGINEERING AND LOGISTICS ENGINEERING ARE CO-OPERATING EACH OTHER THAT A FOLLOWING TABLE WILL EXPLAIN THEIR RELATIONSHIPS.

B) THE PRACTICAL DETAILED WORKS ARE EXPALINED IN FIG. 1 AS THE BASIC FLOW CHART OF LOGISTIC SUPPORT ANALYSIS AT EACH CONCEPTUAL DESIGN, DEVELOPMENT TEST, PRODUCTION/CONSTRUCTION/INSTALLATION, OPERATIO, AND MAINTENANCE PHASES.

C) FIG. 2 IS MORE CLOSE EXPLANATION OF INTER-RELATIONSHIP BETWEEN DESIGN AND LOGISTICS ENGINEERING PROCESSES DEVELOPMENT AS SYSTEM OR EQUIPMENT ARE PROCEEDING ON FROM SOFT-WARE TO HARDWARE.

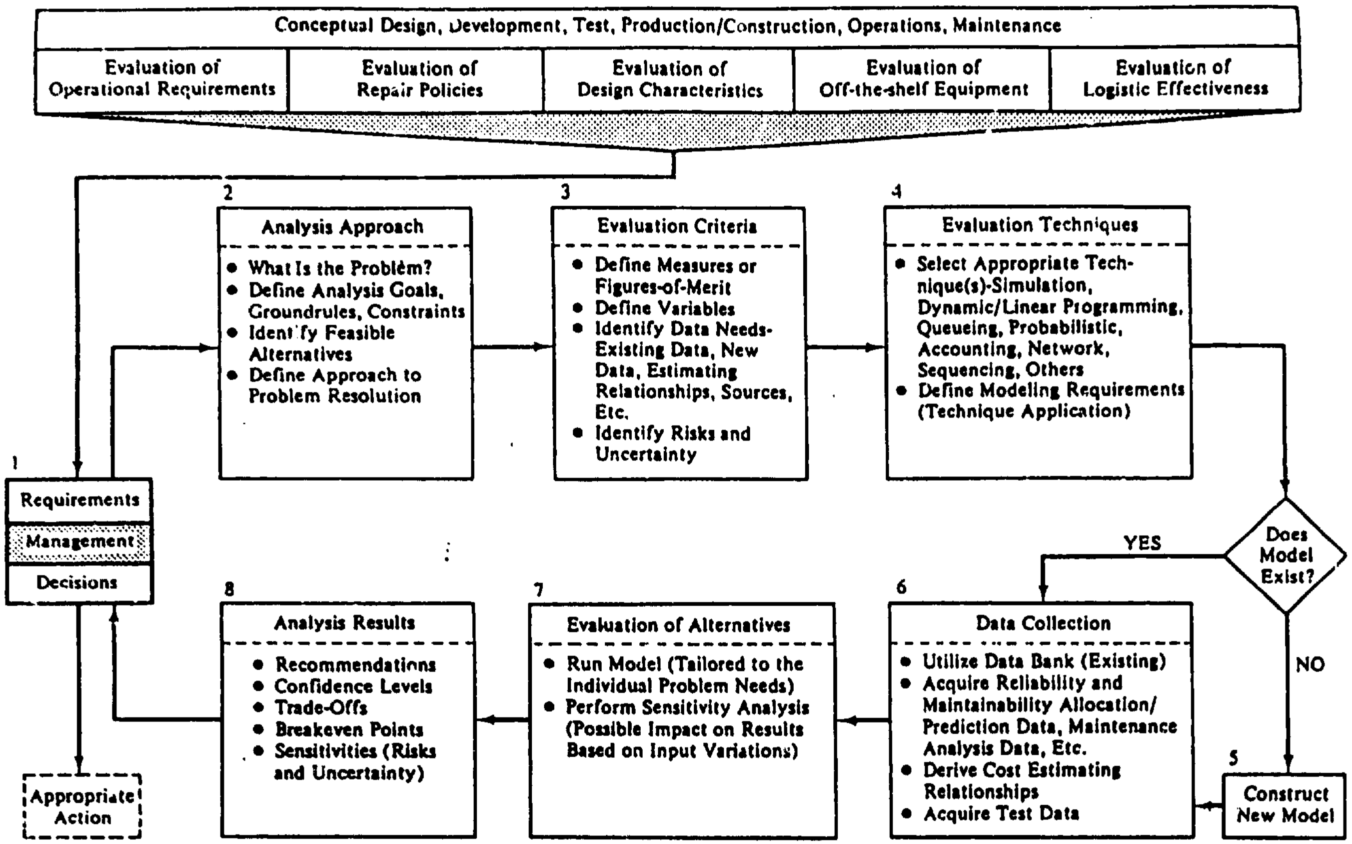


FIG. 1 LOGISTIC FUNCTION AT EACH DESIGN STAGE

(SOURCE: LOGISTICS ENGINEERING AND MANAGEMENT, BY PROF. BEN BLANCHARD, PRENTICE-HALL, 1974)

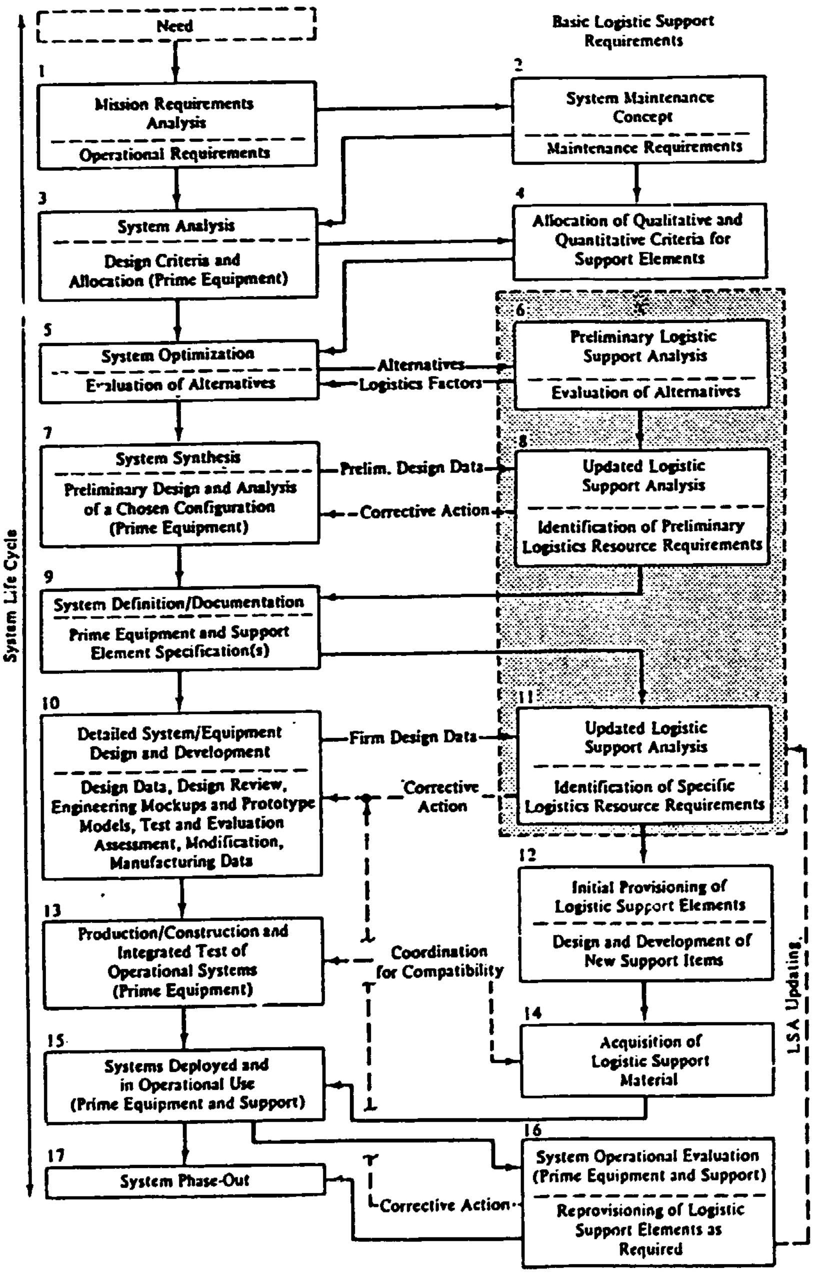
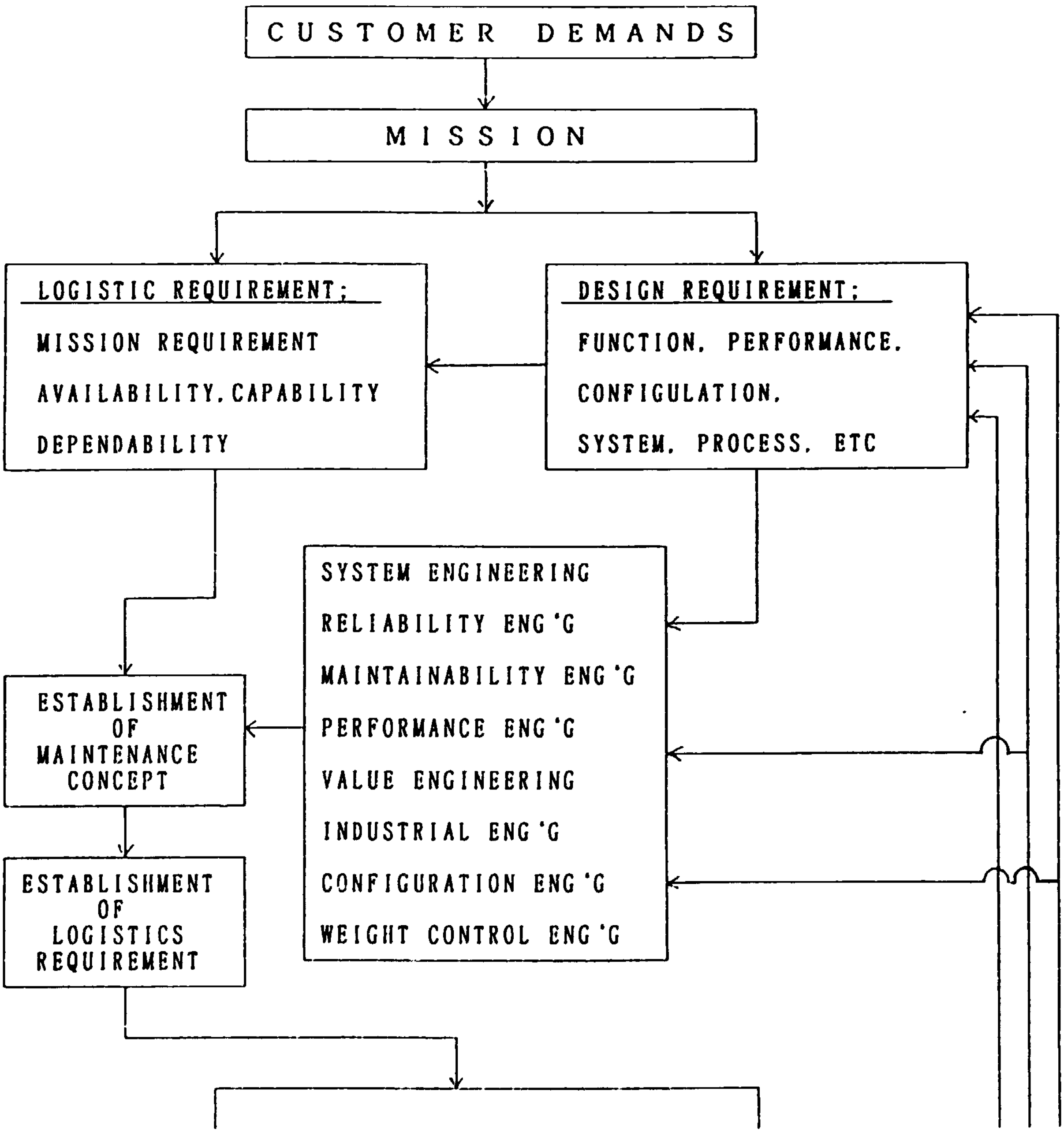
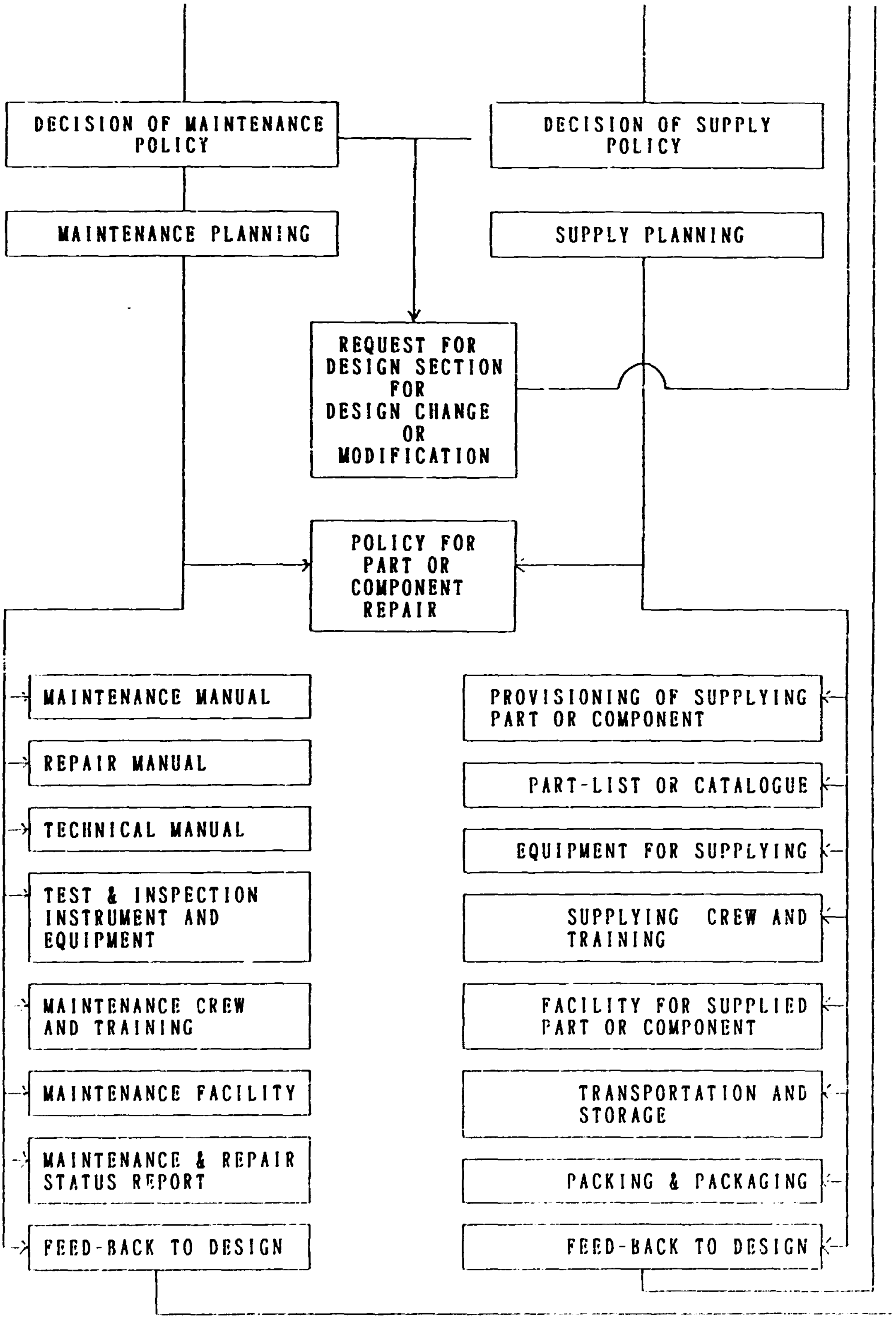


FIG. 2 INTER-RELATIONSHIP BETWEEN DESIGN AND LOGISTICS

(SOURCE: LOGISTICS ENGINEERING AND MANAGEMENT, BY PROF. BEN BLANCHARD, PRENTICE HALL 1974)

C) THE FOLLOWINGS ARE EXPLAINING HOW DESIGN AND LOGISTICS ENGINEERING ARE WORKING TOGETHER FOR ESTABLISHMENT OF COST/SYSTEM EFFFECTIVENESS ACCOMPLISHMENT:




DECISION OF MAINTENANCE POLICY
DECISION OF SUPPLY POLICY
MAINTENANCE PLANNING
SUPPLY PLANNING
REQUEST FOR DESIGN SECTION FOR DESIGN CHANGE OR MODIFICATION
POLICY FOR PART OR COMPONENT REPAIR
MAINTENANCE MANUAL
REPAIR MANUAL
TECHNICAL MANUAL
TEST & INSPECTION INSTRUMENT AND EQUIPMENT
MAINTENANCE CREW AND TRAINING
MAINTENANCE FACILITY
MAINTENANCE & REPAIR STATUS REPORT
FEED-BACK TO DESIGN
PROVISIONING OF SUPPLYING PART OR COMPONENT
PART-LIST OR CATALOGUE
EQUIPMENT FOR SUPPLYING
SUPPLYING CREW AND TRAINING
FACILITY FOR SUPPLIED PART OR COMPONENT
TRANSPORTATION AND STORAGE
PACKING & PACKAGING
FEED-BACK TO DESIGN

6 ILS IMPLEMENTING

6-1 PRE-STUDYING

PRIOR TO IMPLEMENTING OF ILS PROGRAM. IT IS NECESSARY FOR LOGISTIC ENGINEERING TO IDENTIFY A SYSTEM/ EQUIPMENT SPECIFIC FEATURES AS:

A) MISSION REQUIREMENT

-- PRIMARY MISSION
-- WHAT TO ACHIEVE
-- HOW TO ACHIEVE
-- WHERE TO ACHIEVE

B) FUNCTION AND PERFORMANCE CHARACTERISTICS

-- SYSTEM FUNCTION
-- PERFORMANCE CHARACTERISTICS
-- CRITICAL PERFORMANCE
-- SOME CONSTRAINT
-- (DIMENSION, WEIGHT, RANGE, OUTPUTS, ACCURACY, PRECISION, CAPACITY, RELIABILITY, SAFETY MAINTAINABILITY, ETC)

C) OPERATIONAL CONDITION

-- WHEN TO DEPLOY
-- WHERE TO DEPLOY (GEOGRAPHI-CAL LOCATION)
-- WHAT TO BE REQUIRED/EXPECT-ED
-- BOUNDARY CONDITIONS IN USE

D) UTILIZATION REQUIREMENT

-- ANTICIPATED USING CONDITION
-- EXPECTED OPERATION DURATION
-- ANTICIPATED LOADING CONDI-TION
-- ANTICIPATED WORST OPERATION OR ENVIRONMENT

E) REQUIRED OBJECTIVES SPECIFIED

-- COST/SYSTEM EFFECTIVENESS
-- AVAILABILITY BEFORE MISSION
-- DEPENDABILITY
-- MTBF, MTBM, MTBR, MDT, ETC

F) ENVIRONMENT

-- EXPECTED OPERATIONAL EN-VIRONMENT
-- EXPECTED STORGING CONDITION
-- EXPECTED TRANSPORTING

G) LIFE-CYCLE

-- EXPECTED TIME BEING IN USE

6-2 MAINTENANCE CONCEPT

THE MAINTENANCE CONCEPT IS TO SPECIFY

* REPAIR POLICIES
* MAINTENACE SUPPORT LEVEL
* EFFECTIVE MEASURING INDEX
* DETERMINING SPECIFIC FACTORS FOR LOGISTIC SUPPORT (LOGISTIC SUPPORT ANALYSIS)

A) REPAIR POLICY DECISION

A REPAIR POLICY SPECIFIES THE ANTICIPATED EXTENT TO WHICH REPAIR OF AN SYSTEM/EQUIPMENT ITEM BE ACC-OMPLISHED.
EACH POLICY IS EVALUATED IN TERM OF IMPACT ON SYSTEM/EQUIPMENT DESIGN AND LOGISTIC SUPPORT. CRITERIA ARE EATABLISHED, AND SUCH SYSTEM/EQUIMENT DESIGN PROCEED ON WITHIN THE BOUND

OF THE REPAIR POLICY DETERMINED.
THE REPAIR POLICY MAY SPECIFED THAT A PART/COMPONENT/UNIT/ITEM MUST BE DESIGNED TO BE NONREPAIRABLE, PARTIALLY REPAIRABLE, OR FULLY REPAIRABLE

1) NON-REPAIRABLE

GENERALLY, MODULAR OR PACKAGE TYPE IN CONSTRUCTION WITH A RELATIVELY LOW REPLACEMENT COST, IS THE TYPICAL EXAMPLE, THAT IS DISCARDED WHEN A FAILURE OCCURS.
THE SYSTEM/EQUIPMENT IS NECESSARY TO DESIGNED SUCH THAT THE PART/UNIT/ITEM ARE EASILY REMOVABLE(PLUG-IN) TYPE.

2) PARTIALLY REPAIRABLE

THE SELECTION OF SUCH POCICY IS COMPLETELY DEPENDING ON SYSTEM OPERATIONAL REQUIREMENTS THAT IF SYSTEM OPERATIONAL AVAILABILITY SPECIFIES LESS DOWN-TIME PEQUIREMENTS, IT IS NECESSARY TO HAVE A RAPID REMOVAL AND REPLACEMENT. THUS DESIGN CRITERIA SHOULD BE COVERED BUILT-IN SELF-TEST FEATURES, MODULARIZATION(PLUG-IN) AND EASY ACCESSIBILITY.

3) FULL REPAIRABLE SYSTEM

THIS IS A POLICY TO CONSIDER THE MOST SERIOUS LOGISTIC SUPPORT IN TERM OF TEST AND SUPPORT EQUIPMENT. SPARE/REPAIR PARTS. PERSONNEL AND TRAINING. TECHNICAL DATA COVERAGE. AND FACILITIES.

ACCORDINGLY. AT EARLIER OR PRELIMINARY STAGE. IT IS NECESARY TO STUDY WHICH IS THE PREFERRED POLICY APPROACH WHICH IS REQUIRED AS AN INPUT TO THE SYSTEM/EQUIPMENT DESIGN STAGE

B) MAINTENANCE LEVEL

IT IS NECESSARY TO IDENTIFY.

-- WHERE TO CONDUCT MAINTENANCE(LINE. DEPOT. OR PLANT)
-- WHO TO CONDUCT MAINTENANCE
-- WHEN TO CONDUCT MAINTENANCE
-- WHY TO MAINTAIN BY SPECFIC PLACE. PERSONNEL AND TIME
-- TO WHICH PORTION BE MAINTAINABLE
-- WHICH EQUIPMNET BE IN NEED FOR EACH LEVEL STATIONS

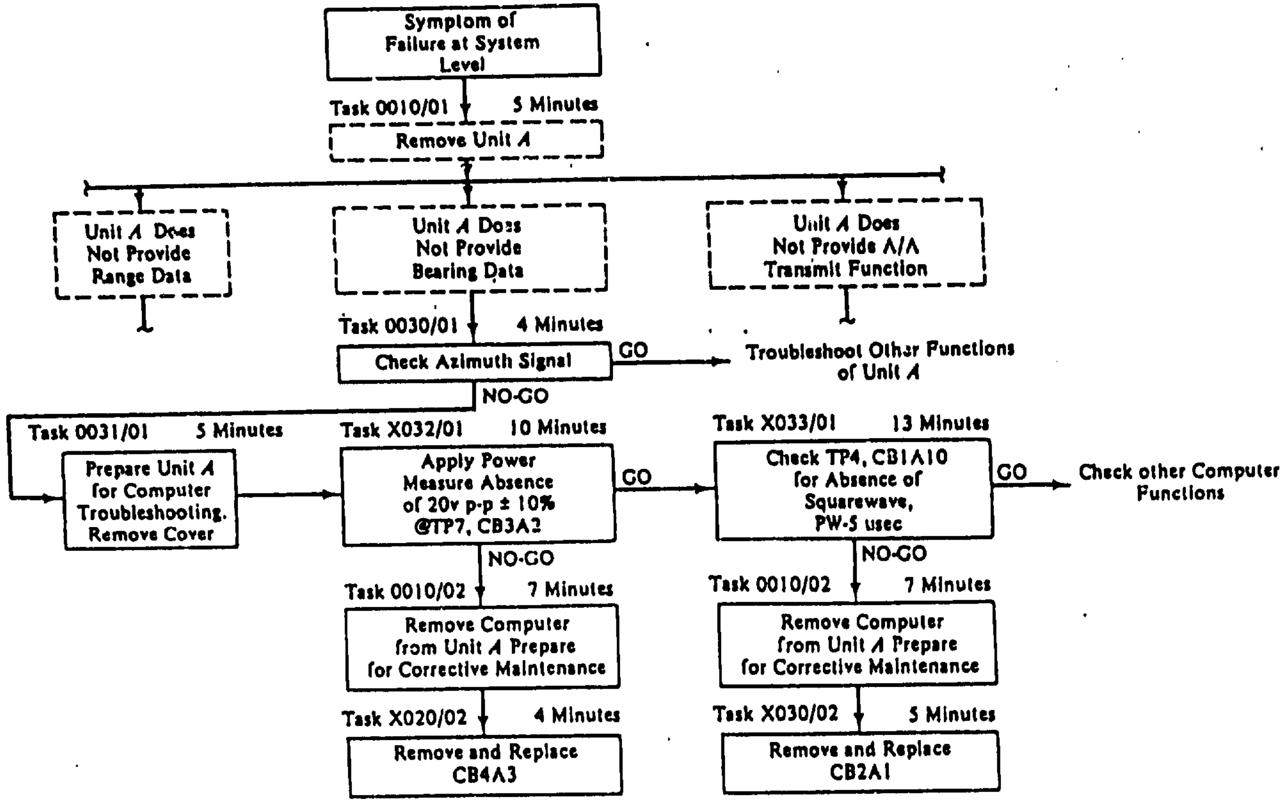


FIG. 3 OPERATIONAL/MAINTENANCE FLOW

(SOURCE: LOGISTICS ENGINEERING AND MANAGEMENT, BY PROF. BEN BLANCHARD, PRENTICE-HALL, 1974)

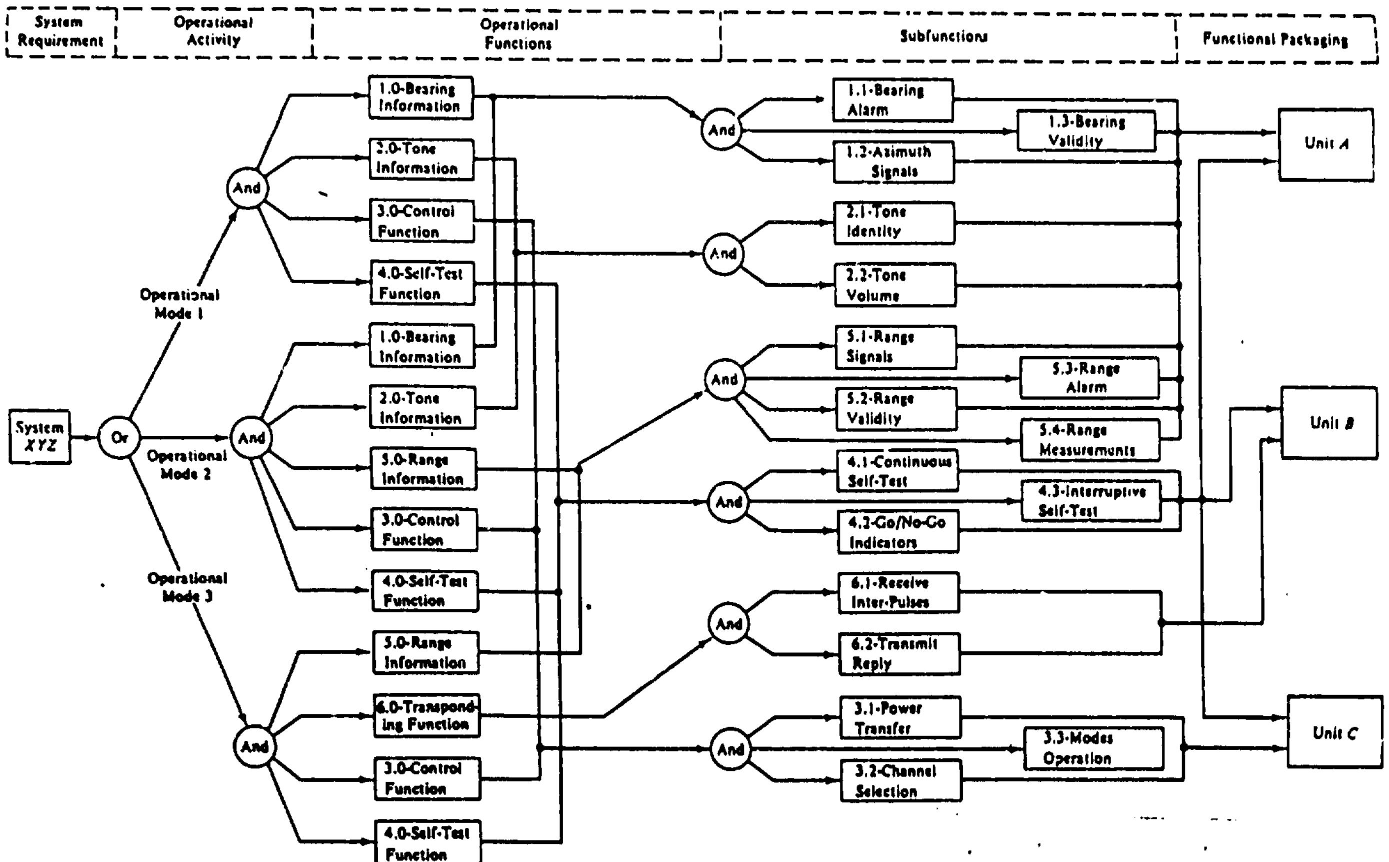


FIG. 4 SYSTEM XYZ OPERATION FUNCTIONAL FLOW

(SOURCE: LOGISTICS ENGINEERING AND MANAGEMENT, BY PROF. BEN BLANCHARD, PRETICE-HALL, 1974)

C) ALLOCATION OF MEASURIMG INDEX

THE TRANSLATION OF SYSTEM/ EQUIPMENT OPERATIONAL AND MAINTENANCE FACTORS INTO SPECIFIC QUALITATIVE AND QUANTITATIVE SYSTEM DESIGN REQUIREMENTS IS ACCOMPLISHED THROUGH A LOGICAL FUNCTIONAL ANALYSIS AND ALLOCATION PROCESS.

1) FUNCTIONAL/PHASE ANALYSIS

THE INITIAL STEP IS TO PREPARE FUNCTIONAL FLOW-CHARTS OF SYSTEM AND ALL FACETS OF SYSTEM DEVELOPMENT AND OPERATION. THIS INCLUEDS DESIGN. PRODUCTION. INSTALLATION. CONSTRUCTION. TEST. DEPLOYMENT. TRAINING. OPERATION. USE. SERVICE AND. MAINTENANCE AS SHOWN IN FIG. 3.

2) OPERATION ANAYSIS

THE ABOVE MENTIONED FLOW-CHART (FIG. 1) ILLUSTRATE AN OVERALL PORTRAYAL OF THE FUNCTION WHICH ARE NECESSARY TO DESCRIBE TOTAL SYSTEM ACTIVITIES. FIG. 4 REPRESENTS A TYPICAL SYSTEM OPERATIONAL FUNCTION FLOW DIAGRAM.

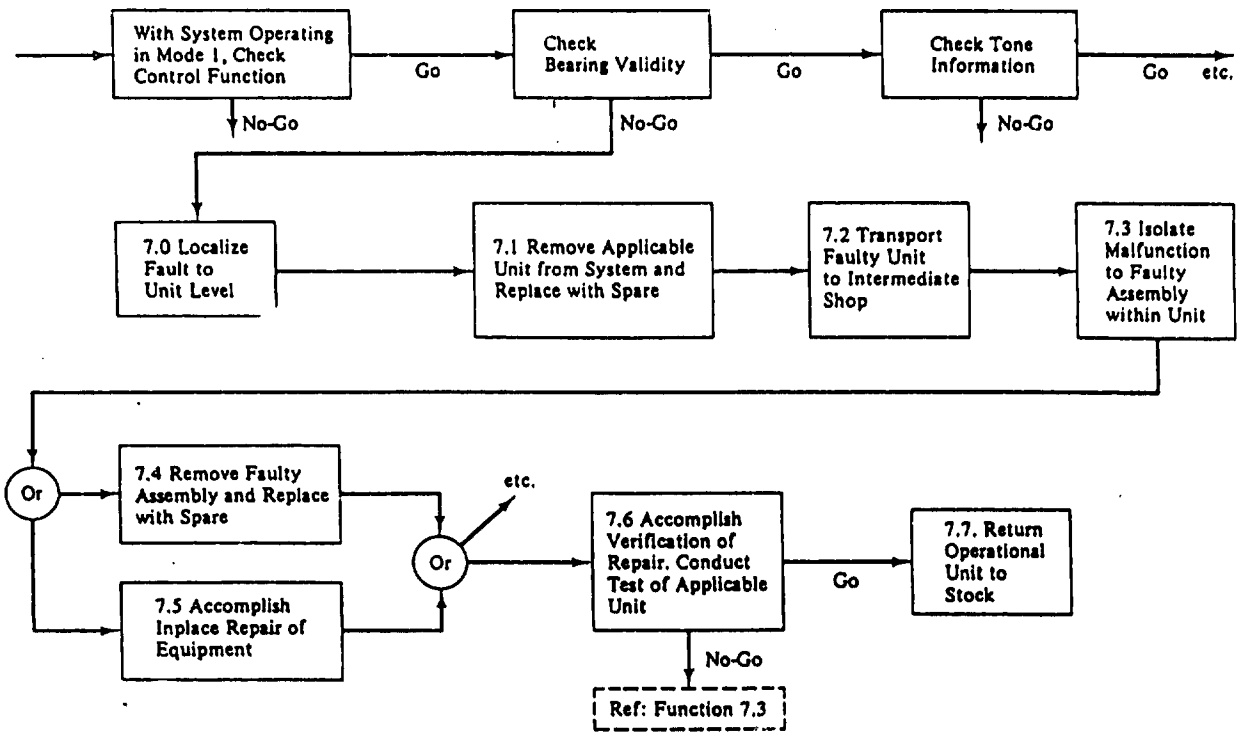


FIG. 5 MAINTENANCE FUNCTIONAL FLOW

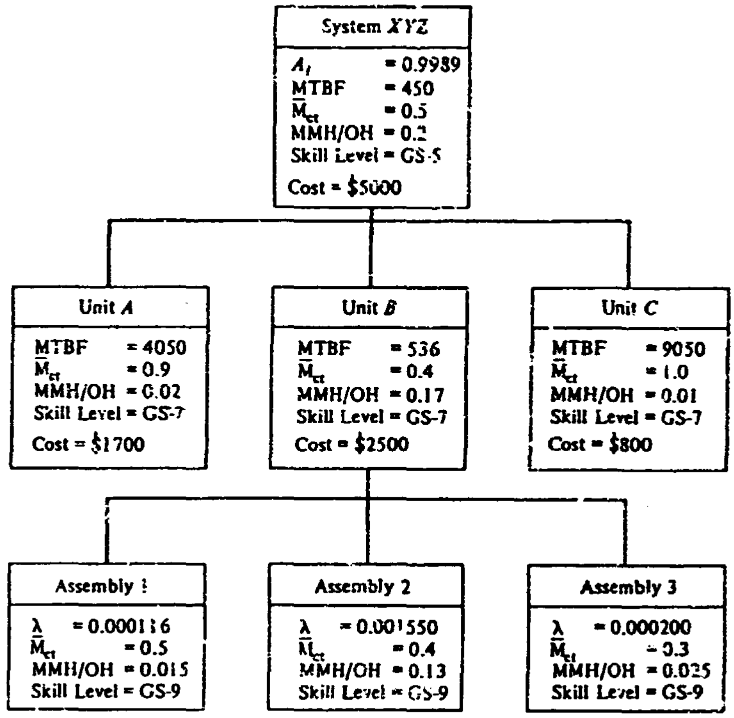
(SOURCE: LOGISTICS ENGINEERING AND MANAGEMENT, BY PROF. BEN BLANCHARD, PRENTICE-HALL, 1974)

3) MAINTENANCE FUNCTION

ONCE OPERATIONAL FUNCTIONS ARE DEFINED, THE SYSTEM DESCRIPTION LEADS TO THE DEVELOPMENT OF GROSS MAINTENANCE FUNCTIONS. (RE. TO FIG. 5) A CHECK OF THE APPLICABLE FUNCTION WIIL INDICATE EITHER A GO OR NO GO DECISION. A GO DECISION LEADS TO A CHECK OF THE NEXT OPERATIONAL FUNCTION. A NO-GO INDICATION (CONSTITUTING A SYMPTOM OF MALFUCTION) PROVIDES A STARTING POINT FOR THE DEVELOPMENT OF DETAILED MAINTENANCE FUNCTION FLOWS AND LOGIC TROUBLE SHOOTING DIAGRAM.

B) ALLOCATION OF REQUIREMENT

RELIABILITY AND MAITAINABILITY ALLOCATION PROCEDURES ARE EXPLAINED IN VARIOUS DOCUMENTATIONS THAT IT IS HEREBY SHOWN SOME EXAMPLES FOR YOUR RFERENCESDS IN FIG. 6.



SYSTEM *XYZ* ALLOCATION

1 Item	*2* Quantity of Items per System (Q)	*3* Failure Rate (λ) × 1000 Hr	*4* Contribution of Total Failures $C_f = (Q)(\lambda)$	*5* Percent Contribution $C_p = C_f/\sum C_f \times 100$	*6* Average Corrective Maint. Time $\bar{M}ct$ (hr)	*7* Contribution of Total Corrective Maint. Time $C_t = (C_f)(\bar{M}ct)$
1. Unit *A*	1	0.246	0.246	11%	0.9	0.221
2. Unit *B*	1	1.866	1.866	84%	0.4	0.746
3. Unit *C*	1	0.110	0.110	5%	1.0	0.110
Total			$\sum C_f = 2.222$	100%		$\sum C_t = 1.077$

$$\bar{M}ct \text{ for System } XYZ = \frac{\sum C_t}{\sum C_f} = \frac{1.077}{2.222} = 0.485 \text{ Hour (Requirement: 0.5 Hour)}$$

UNIT *B* ALLOCATION

1	2	3	4	5	6	7
Assembly 1	1	0.116	0.116	6%	0.5	0.058
Assembly 2	1	1.550	1.550	83%	0.4	0.620
Assembly 3	1	0.200	0.200	11%	0.3	0.060
Total			1.866	100%		0.738

$$\bar{M}ct \text{ for Unit } B = \frac{\sum C_t}{\sum C_f} = \frac{0.738}{1.866} = 0.395 \text{ Hour (Requirement: 0.4 Hour)}$$

FIG. 5 SYSTEM XYZ ALLOCATION

(SOURCE: LOGISTICS ENGINEERING AND MANAGEMENT, BY PROF. BEN BLANCHARD, PRENTICE-HALL, 1974)

D) LOGISTIC SUPPORT ANALYSIS (LSA)

THE LOGISTIC SUPPORT ANALYSIS IS USUALLY RECOMMEND TO FOLLOW THE PROCEDURES IN FIG. , TO SOLVE DIFFERENT TYPE OF PROBLEM WHICH WILL EVALUATE OF SYSTEM OPERATIONAL EFFECTIVENESS, MISSION ACCOMPLISHMENT, EQUIPMENT DEPLOYMENT, UTILIZATION WITH MOST COST-EFFECTIVE METHODS.

1) DEFINITION OF PROBLEM

AFTER CLARIFICATION OF OBJECTIVES OF SYSTEM, IT IS TO DEFINE WHAT IS/ARE THE MOST CONCERNS, BASED ON VITAL-FEW CONCEPT IN LOGISTIC REQUIREMENT.

2) IDENFICATION OF FEASIBLE ALTERNATIVES

IT IS DESIRABLE TO LIST-UP ANY POSSIBLE CANDIDATES TO ENSURE AGAINST INADVERTENT OMISSION, AND THEN, ELIMINATE THOSE CANDIDATES WHICH ARE CLEARLY, UNREASONABLE, LEAVING ONLY A VETAL-FEW FOR EVALUATION. THOSE FEW CONDIDATES ARE THEN ANALYZED DWITH THE INTENTFFF SELECTING A

1. **Maintenance Echelons**

2. **Maintenance Tasks/Echelon**
   - Task Sequences
   - Task Time
   - Task Frequency

3. **Test and Support Equipment**
   - Quantity and Type/Echelon
   - Utilization Rate
   - Utility Requirements
   - R & D Cost
   - Investment Cost
   - O & M Cost

4. **Spare/Repair Parts**
   - Repair Levels
   - Nonrepairable or - Consumable Items-Quantity and Type
   - Repairable Items-Quantity and Type
   - Replacement Frequency
   - Inventory Level
   - Safety Stock Level
   - Condemnation Rate
   - Hi-Value Items
   - Provisioning Cycle
   - Pipeline Time
   - Wearout Rate
   - Shelf Life
   - Spares Availability
   - Order Cost
   - Inventory Holding Cost
   - Material Cost

5. **Personnel and Training**
   - Personnel Quantity, Rating and Skill Level Requirements/Echelon
   - Attrition Rate
   - Learning Curve
   - Personnel Effectiveness
   - Personnel Cost-Direct Cost and Overhead
   - Initial Training Requirements-Personnel Quantity and Type
   - Replenishment Training Requirements-Personnel Quantity and Type
   - Training Courses
   - Training Data
   - Training Equipment
   - Personnel Training Cost
   - Training Data and Equipment Costs

6. **Technical Data**
   - Technical Manual Requirements
   - Logistics Provisioning Data
   - Data Collection System Requirements
   - Initial Data Cost
   - Change Data Cost

7. **Transportation and Handling**
   - Equipment Requirements—Quantity, Type, Location
   - Packaging (Containers) and Shipping
   - Equipment Cost (R & D, Investment, O & M)
   - Transportation Cost

8. **Modifications**

9. **Facilities**
   - Operational, Maintenance and Training Facility Requirements
   - Facility Utilization
   - Space Requirements—Layout
   - Storage Requirements
   - Utility Requirements (Electrical Power, Light, Heat, Water)
   - Capital Equipment
   - Tooling and Special Handling Equipment
   - Environmental Requirements (Shielding, Clean Room, etc.)
   - Facilities Cost (R & D, Investment, O & M)

10. **Additional Factors**
   - Availability (A_o, A_a, A_i)
   - MTBM, MTBF, λ, $\hat{R}$, MTBR
   - Cost/System Effectiveness
   - MDT, M_{ct}, $\bar{M}_{pt}$, M_{ct}, M_{pt}, $MTTR_G$, M_{max}, $\bar{M}$, Confidence Level
   - MMH/OH, MMH/MO, MMH/YR
   - Turnaround Time (TAT)
   - Self-Test Thoroughness
   - Maintenance Actions/Year
   - Dependability
   - Life-Cycle Cost (R & D, Investment, O & M)
   - Cost/MA, Cost/OH
   - Escalation Factor
   - Discount Rate
   - Prime Equipment Utilization
   - Failure Modes, Effects, Criticality

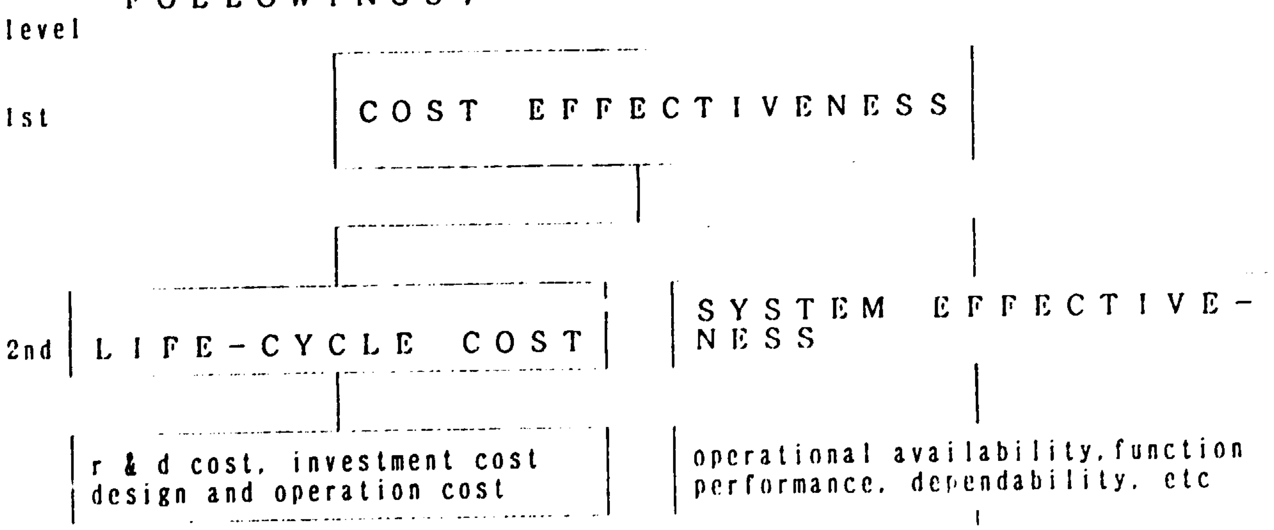
FIG. 7 LOGISTIC SUPPORT ANALYSIS DATA OUTPUT SUMMARY

(SOURCE: LOGISTICS ENGINEERING AND MANAGEMENT, BY PROF. BEN BLANCHARD PRENTICE-HALL, 1974)

PREFERRED APPROACH.

3) SELECTION OF EVALUATION CRITERIA

THE CRITERIAL IN THE EVALUATION PROCESS MAY VARY CONSIDERABLY DEPENDING ON THE STATED PROBLEM AND THE LEVEL AND COMLEXITY OF THE ANALYSIS. FOR INSTANCES, AT THE RATHER HIGHER LEVEL--SYSTEM LEVEL PARAMETER FOR EVALUATION INCLUDES COFT EFFECTIVENESS, SYSTEM EFFECTIVENESS, LOGISTICS EFFECTIVENESS, LIFE-CYCLE COST, OPERATIONAL AVAILABILITY, PERFORMANCE AND SO ON. AT THE LOWER LEVEL, THE ORDER OF PARAMETERS WILL BE DIFFERRENT WHICH ARE MORE SPECIFIC ONES ARE EVALUATED AS MENTIONED IN THE FOLLOWINGS:



3rd	test and support equipment	reliability
	spare/repair parts	maintainability
	personnel and training	human factors
	technical data	producibility
	facilities	functional design
	transportation and handling	performance design

4th	* ACCESSIBILITY	* PACKING AND PACAGING
	* DIAGNOSTIC AIDS	* PERSONNEL SKILL
	* DISPLAYS/CONTROL	* SAFETY
	* HANDLING	* STANDARDIZATIO
	* INTERCHANGEABILITY	* STORAGE
	* REPLACEABILITY	* TEST APPARATUS
	* INVENTORY LEVEL	* TRANSPORTATION MEDIA
	* LOGISTICS PIPELINE	* OTHERS
	* MOUNTING	

IN ANOTHER WORD, THE LOWER LEVEL, THE MORE SPECIFIC PARAMETERS ARE NECESSARY TO EVALUATE FOR THE STANDPOINTS OF RELEVANCY OR DEGREE OF IMPORTANCE, WEIGHT PARAMETER COULD BE THE MOST IMPORTANT FACTOR.

4) APPLICATION OF ANALYTICAL TECHNIQUES

THE SELECTION OR COMBINATION OF ANALYTICAL MODEL OR METHDOLOGY IS RECOMMENED MOST SIMPLIFIED ONES TO REPRESENT OF THE REAL WORLD WHICH ABSTRACTS THE FEATURES OF THE SITUATION RELATIVE TO THE PROGLEM BEING ANALYZED.
IN ANY EVENT, ENGINEERS MIGHT ATTEMPT TO ANSWER THE FOLLOWINGS:

* CAN THE MODEL DESCRIBE KNOWN FACTS AND SITUATIONS SUFFICIENTLY WELL?
* WHEN MAJOR INPUT PARAMETERS ARE VARIED, DO THE RESULTS REMAIN CONSISTENT AND ARE THEY REALISTIC ?
* RELATIVE TO SYSTEM APPLICATION, IS THE MODEL SENSITIVE TO CHANGE IN OPERATIONAL REQUIREMENTS, PRODUCTION/CONCTRUCTION OR INSTALLATION AND LOGISTIC SUPPORT ?
* CAN CAUSE AND EFFECT RELATIONSHIP BE ESTABLISHED ?

5) DATA GENERATION AND APPLICATION

ONE OF THE MOST IMPORTANT STEPS IN THE ANALYSIS PROCESS IS TO ASSEMBLE THE APPROPRIATE INPUT DATA.
THE RIGHT TYPE OF DATA MUST BE COLLECTED IN A TIMELY MANNER AND MUST BE PRESENTED IN THE PROPER FORMAT.
THE SOURCE OF DATA MAY BE SUMMARIZED IN THE FOLLOWING CATEGORIES:

* CURRENT DATA BANK
* ESTIMATING RELATIONSHIPS. WHICH RELATE ONE PARAMETER IN TERMS OF ANOTHER, PROVIDE RULE OF THUMB OR SIMPLE ANALOGIES FROM WHICH SPECIFIC FACTORS ARE DERIVED
* FUNCTIONAL ANALYSIS, ALLOCATIONS, RELIABILITY, AND MAINTAINABILITY PREDICTIOBNS, MAINTAINABILITY ANALYSES, AND RELATED PROJECT REPORTS PROVIDED MUCH OF THE REQUIRED INPUT DATA WHEN EQUIPMENT DESIGN INFORMATION IS FIRST AVAILABLE.
* ENGINEERING TEST DATA AND FEILD DATA ON EQUIPMENT IN USE.

6) ANALYSIS RESULTS

AFTER INTEGATION AND APPLICATION OF DIFFERENT ANALYTICAL TECHNIQUE APPLIED TO A VARIETY OF PROBLEM SITUATIONS.
AND LOGISTIC SUPPORT ANALYSIS IS DEVELOPED ON A PROGRESSIVE BASIS AND AND THE OUTPUT DATA WILL VARY FROM APPLICATION TO APPLICATION THAT SOME EXAMPLES BE SHOWN FOR REFERANCES AS FIG. 7.

7) SENSITIVITY ANALYSIS

IN PERFORMANCE OF A GIVEN ANALYSIS, THERE MAY BE A FEW KEY PARAMETERS ABOUT WHICH THE ANALYST IS VERY UNCERTAIN (DUE TO INADEQUATE DATA, PUSHING THE STATE-OF-ART, ETC).
THE QUESTION IS " HOW SENSITIVE ARE THE RESUSLTS OF ANALYSIS VARIATIONS TO THESE UNCERAIN PARAMETERS ?
VARIATION IS ACCOMPLISHED BY APPLYING DIFFERENET MULTIPLE FACTORS TO THE INPUT PARAMETER BEING TESTED: AS

* VARIATION OF MTBF AS A FUNCTION OF TOTAL LIFE-CYCLE COST AND SPARE/REPAIR PART REQUIREMENT.
* VARIATION OF SYSTEM UTILIZATION OR OPERATING TIME AS A FUNCTION OF THE QUANTITY OF MAINTENANCE ACTION, TEST AND SUPPORT EQUIPLMENT UTILIZATION, AND FACILITY USAGE.
* VARIATION OF $\overline{M}ct$ AS A FUNCTION OF PERSONNEL MAINTENANCE COST
* VARIATION OF LOGISTICS PIPE LINE TIME AS A FUNCTION OF SPARE/REPAIR PART COST.
* VARIATION OF CONDEMNATION RATE AS A FUNCTION OF SPARE/REPAIR PART COST.
* VARIATION OF DISCOUNT RATE AS A FUNCTION OF LIFE-CYCLE COST

8) CONTINGENCY ANALYSIS

CLOSELY RELATED WITH THE SENSITIVITY ANALYSIS IS THE CONTINGENCY ANALYSIS WHICH INVOLVES THE INVESTIGATION OF DECISION IN TERMS OF RELEVANT CHANGES IN

THE INITIAL CRITERIA.
AS NEW SYSTEMS ARE BEING DEVELOPED. THERE IS ALWAYS THE POSSIBILITY THAT THE BASIC REQUIREMENT WILL CHANGE. TO THE EXTENT POSSIBLE. THE ANALYST MUST ANTICIPATE SUCH CHANGE. APPLY THE LOGISTIC SUPPORT ANALYSIS APPROPRIATEL. AND ALERT MANAGEMENT AS TO THE IMPACT OF THE CHANGE ON THE PRIME EQUIPMENT AND ITS ASSOCIATED LOGISTIC SUPPORT.

9) RISK AND UNCERTAINTY

THE PROCESS OF EVALUATION LEADS TO DECISIONS HAVING SIGNIFICANT IMPACT ON FUTURE. INHERENT IN THIS PROCESS ARE THE ASPECTS OF RISK AND UNCERTAINTY SINCE THE FUTURE IS. CERTAINLY. UNKNOWN.
AS THE INTENT IN ANY EVALUATION PROCESS IS TO MINIMIZE RISK AND UNCERTAINTY. THE APPROACH MUST EMPLOY PROPERLY THE FOLLOWING STATED BASIC AREAS (NOT TO BE CONSIDERED AS ALL INCLUSIVES)

* SELECTION OF EVALUATION CRITERIA
* WEIGHING OF EVALUATION FACTORS (USE DELPHI-TECHNIQUE)
* THE USE OF RATIOS AS MEANS OF EVALUATION SCORING
* THE SELECTION OF AN OPERATIONAL HORIZON
* DATA INPUT

10) VALIDITY OF THE ANALYSIS

AS A FINAL CHECK, A NUMBER OF QUESTIONS MAY BE POSED AS TO THE VALIDITYOF THE STATED ASSUMPTION, MODEL PARAMETER RELATIONSHIPS, INCLUSION/EXCLUSIONS, AND STATED CONCLUSIONS.
AS A REFERENCES, TYPICAL EVALUTION CHECK SHEFT IS ATTACHED, IN FIG. 8.

A. Assumptions

1. Are all assumptions adequately identified?
2. Do any of the specified assumptions treat quantitative uncertainties as facts?
3. Do any of the specified assumptions treat qualitative uncertainties as facts
4. Are major assumptions reasonable?

B. Alternatives

1. Are current capabilities adequately considered among alternatives?
2. Are mixtures of systems considered among the alternatives?
3. Are any feasible and significant alternatives omitted?

C. Documentation

1. Is the study adequately documented?
2. Are the facts stated correctly?
3. Are the facts stated with proper qualification?
4. Are all applicable reference sources listed?

D. Model Relationships

1. Does the model adequately address the problem?
2. Are cost and effectiveness parameters linked logically?
3. Does the model allow for a timely response?
4. Does the model provide valid (comprehensive) and reliable (repeatable) results?
5. Has a sensitivity analysis been performed?

E. Effectiveness Parameters

1. Are the measures of effectiveness identified?
2. Is the effectiveness measure appropriate to the mission function? Are operational and maintenance concepts adequately defined? Are logistic support requirements adequately defined?
3. Do the effectiveness measures employed ignore some objectives and concentrate on others?
4. Are performance measures mistaken for effectiveness measures?
5. Does the effectiveness of a future system take into account the time dimension?
6. Are expected and average values used correctly to measure effectiveness?
7. If quantitative measures of effectiveness are unattainable, is a qualitative comparison feasible?
8. Is the effectiveness measure sensitive to changes in assumptions?
9. In the event that two or more effectiveness measures are appropriate, are the measures properly weighted (the relative weighting in terms of significance or level of importance of each applicable criterion factor employed)?

F. Cost

1. Are cost categories adequately defined?
2. Are cost estimates relevant?
3. Are incremental and marginal costs considered?
4. Are variable and fixed costs separately identifiable?
5. Are escalation factors specified and employed?
6. Are learning curves specified and employed?
7. Is the discount rate specified and employed?
8. Are all costs elements considered? Conceptual/Feasibility Studies; Design and Development; Evaluation Test; Production/Construction; Installation and Checkout; Personnel and Training; Technical Data; Facility Construction and Maintenance; Spare/Repair Parts; Test and Support Equipment; Inventory Maintenance; Transportation and Handling; Program Management?
9. Are the cost aspects of all alternatives treated in a consistent and comparable manner?
10. Are the cost estimates (cost estimating relationships) reasonably accurate? Are areas of risk and uncertainty identified?
11. Is cost amortization employed? If so, how?
12. Has the sensitivity of cost estimates been properly addressed through a sensitivity analysis?

G. Conclusions and Recommendations

1. Are the conclusions and recommendations logically derived from the material contained in the study?
2. Have all the significant ramifications been considered in arriving at the conclusions and recommendations presented?
3. Are the conclusions and recommendations really feasible in light of political, cultural, policy or other considerations?
4. Do the conclusions and recommendations indicate bias?
5. Are the conclusions and recommendations based on external considerations?
6. Are the conclusions and recommendations based on insignificant differences?

H. Reference

TM 38-710, NAVMAT P-4000, AFP-800-7, Integrated Logistic Support Implementation Guide for DOD Systems and Equipments.

FIG. 8 ANAYSIS CHECK-SHEET

(SOURCE: LOGISTICS ENGINEERING AND MANAGEMENT, BY PROF. BEN BLANCHARD PRENTICE-HALL, 1974)

7 LOGISTIC SUPPORT MANAGEMENT

LOGISTIC SUPPORT MANAGEMENT INVOLVES THE PLANNING, ORGANIZATION, DIRECTION, AND CONTROL OF ALL FUNCTIONS AND ACTIVITIES AS MENTIONED BEFORE, WHICH WILL BE CONDUCTED AT:

A) CONCEPTUAL PHASE
B) ADVANCED DEVELOPMENT PHASE
C) DETAILED DESIGN AND DEVELOPMENT PHASE
D) PRODUCTION, CONSTRUCTION AND/OR INSTALLATION PHASE
E) OPERATIONAL/USE PHASE

HOWEVER, ACCORDING TO EXPERIENCES, THE MOST IMPORTANCE(REFER TO FOLLOWING FIG. 11), IS WHOLLY DEPENDING ON THE INITIAL PHASE SUCH AS PRODUCT PLANNING PHASE DECISION WILL GOVERN 66 % OF LIFE-CYCLE COST, AND WHEN FINISHED DESIGN PHASE, 85 % OF LCC ARE ALREADY BE DEFINED AS SHOWN IN FIG. 9. ACCORDINGLY, HOW MUCH MAINTENANCE CREW BE PAID FOR IMPROVEMENT FOR AVAILABILITY OR DEPENDABILITY, THEIR

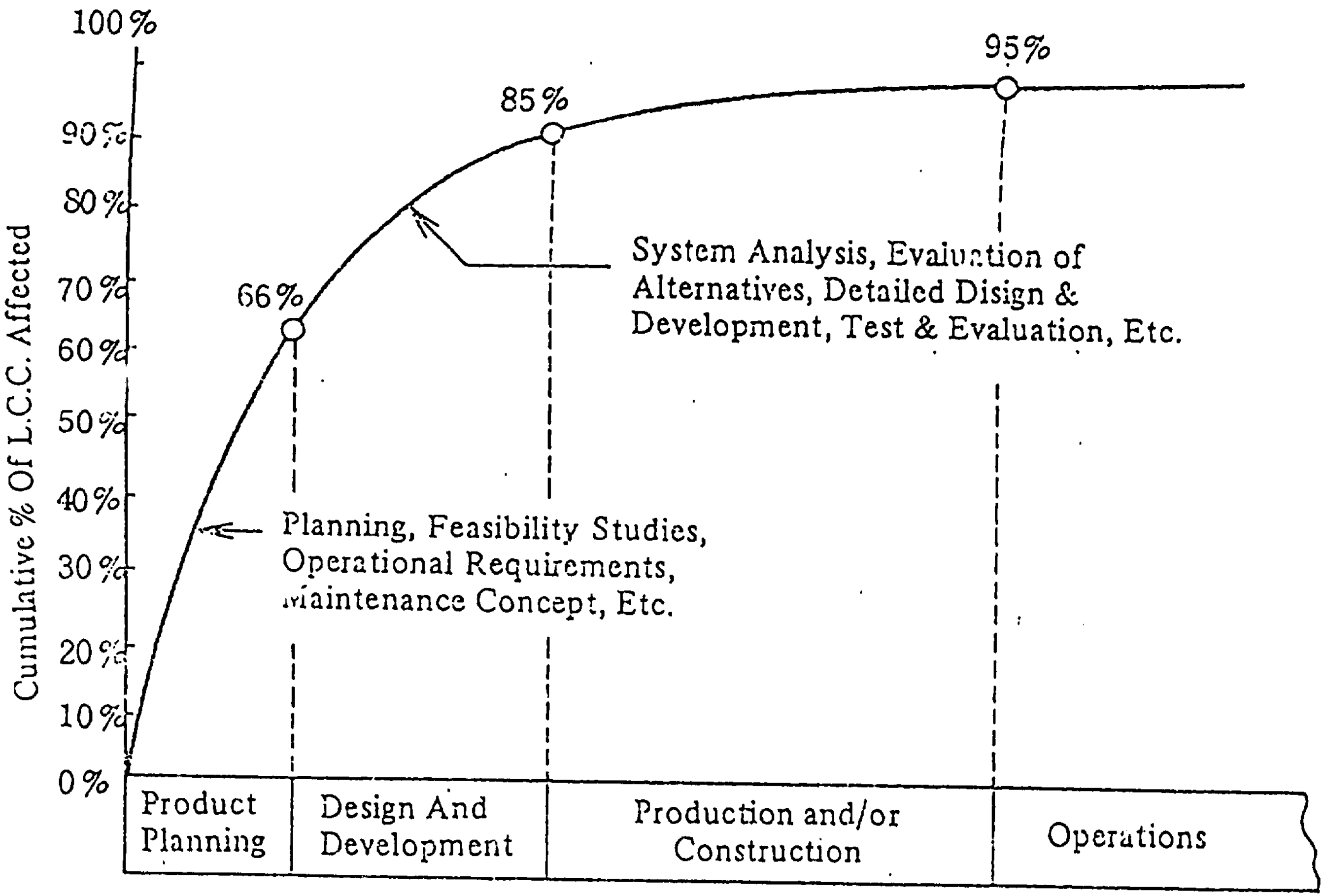


FIG. 9 GENERATION OF LIFE-CYCLE COST

CONTRIBUTION ARE ONLY WITHIN 5 % THAT EVERY DESIGN ENGINEERS ARE REQUESTED TO DO THEIR BEST LOGISTIC DESIGN EFFORTS AT UPPER STREAM PHASE

7-1 LOGISTIC PLANNING

THE LOGISTIC PLANNING ARE ASSOCIATED WITH THE PRESCRIBED 5 PHASES, AND EACH TASKS ARE RECOMMENDED FOLLOW THROUGH AS FIG. 10.
AND THEIR FLOW-DIAGRAM ILLUSTRATED THEIR INTER-RATIONSHIP ARE ALSO IN FIG. 11 AND 12.
TYPICAL SCHEDULE PROGRAM IS STATED IN FIG. 13.

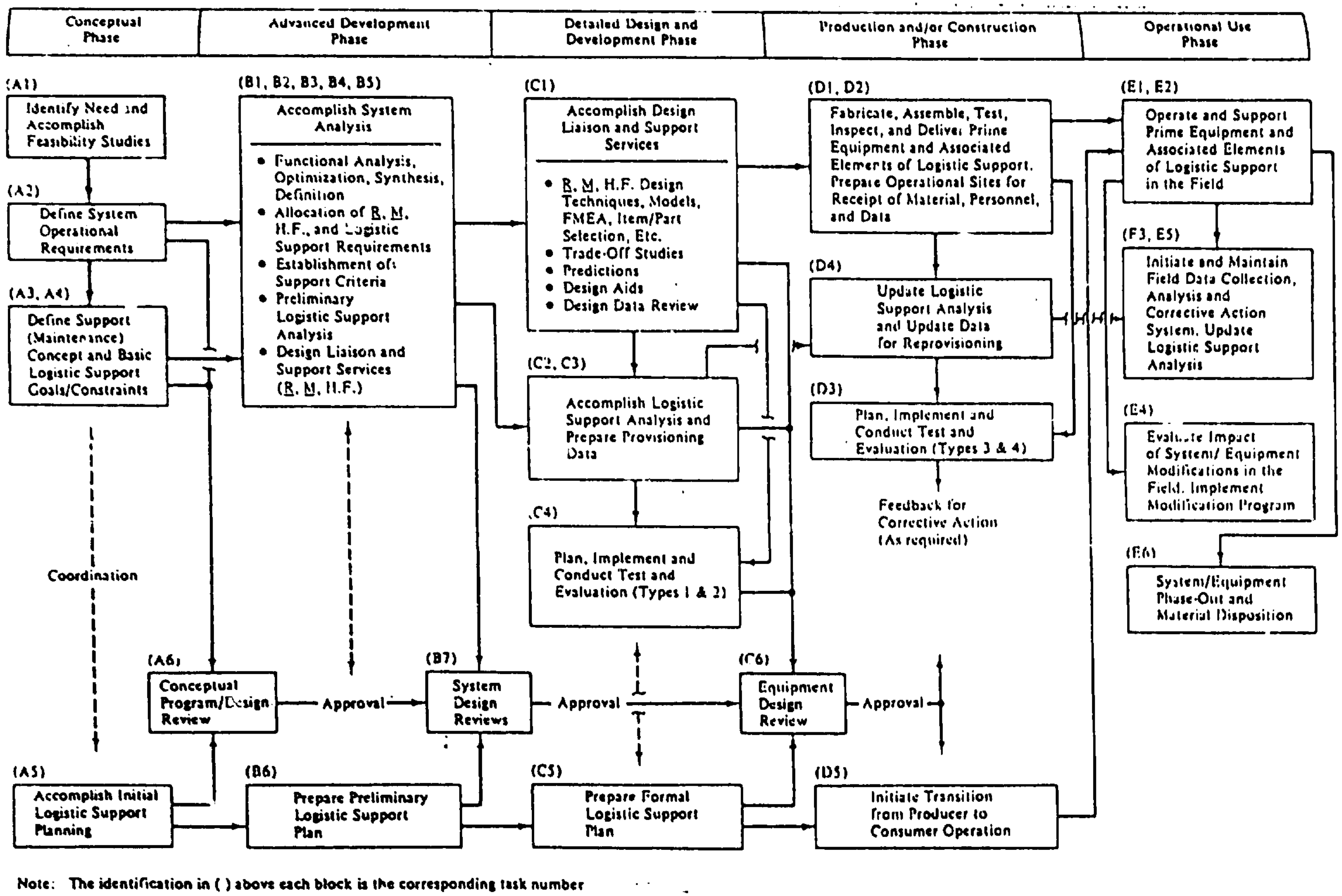
7-2 SUPPLY SUPPORT PLAN

THE SUPPLY SUPPORT PLAN IS NECESSARY TO COVER THE BOTH PREOPERATINAL SUPPORT AND FULL OPERATIONAL SUPPORT DEPENDING ON THE STATUS OF NEW PRODUCT DEVELOPMENT PROGRESSES.
THE PLAN, COVERING BOTH SITUATIONS AS APPLICABLE, INCLUDES

Conceptual Phase	Advanced Development Phase	Detailed Design and Development Phase	Production and/or Construction Phase	Operational Use Phase
A1. Identify need and accomplish feasibility studies. A2. Define system operational requirements—mission definition, performance parameters, deployment, life-cycle, utilization, effectiveness factors (R, M, A), environment. A3. Define support (maintenance) concept—echelons, maintenance site locations, support effectiveness factors (R, M, Logistics), environment. A4. Define basic logistic support goals/constraints—test and support equipment, spare/repair parts, personnel, facilities, data. A5. Accomplish initial logistics planning—define program tasks, schedules, acquisition sources, funding, organizational structure. A6. Participate in conceptual program/design review.	B1. Accomplish functional analysis, optimization, synthesis, and system definition—operator functions, maintenance functions. B2. Accomplish allocation of reliability, maintainability, human factors, and logistic support requirements. B3. Establish supportability design criteria (R, M, H.F., Logistics). B4. Accomplish preliminary logistic support analysis—evaluation of alternatives using cost effectiveness, life-cycle cost, maintenance analysis, and logistics modeling techniques. B5. Accomplish design liaison and support services—reliability and maintainability analysis, design consultation, project training, design data review, predictions. B6. Prepare preliminary logistic support plan—program tasks, schedules, funding, organization, direction, control methods. Include reliability, maintainability, and human factors program plans. B7. Participate in system design reviews.	C1. Accomplish design liaison and support services—application of design criteria, trade-off studies, project training, reliability and maintainability predictions, utilization of design aids, design data review, feedback and corrective action. C2. Accomplish logistic support analysis—system/equipment design evaluation and determination of logistic support requirements (test and support equipment, spare/repair parts, personnel and training transportation and handling, technical data, facilities). C3. Prepare provisioning data for the acquisition of logistic support elements. C4. Plan, implement, and participate in test and evaluation (Types 1 and 2 tests)—data collection, analysis, and corrective action. C5. Prepare formal logistic support plan (individual logistic element plans). C6. Participate in formal equipment design reviews.	D1. Fabricate, assembly, test, inspect and deliver prime equipment, and associated elements of logistic support (hardware and software)—test and support equipment, spare/repair parts, training equipment, data, facilities. D2. Prepare operational sites for receipt of production items—initial personnel training, supply support, facility development, etc. D3. Plan, implement, and participate in test and evaluation (Types 2 and 3 tests)—data collection, analysis, and corrective action. D4. Update logistic support analysis data to enable evaluation of the system and verify logistic factors for use in reprovisioning. D5. Initiate transition from producer to consumer operation.	E1. Operate and support (maintain) prime equipment and associated elements of logistic support in the field. E2. Provide interim support capability (as required) until full operational capability is attained—field service engineers, specialized repair capability, preliminary data, etc. E3. Initiate and maintain field data collection system—data analysis evaluation, and corrective action. E4. Evaluate impact of system/equipment modifications in the field. Plan and implement modification program as necessary. E5. Update logistic support analysis and accomplish reprovisioning as required to support the system throughout its life-cycle. E6. Plan and implement equipment phase-out and disposition program.

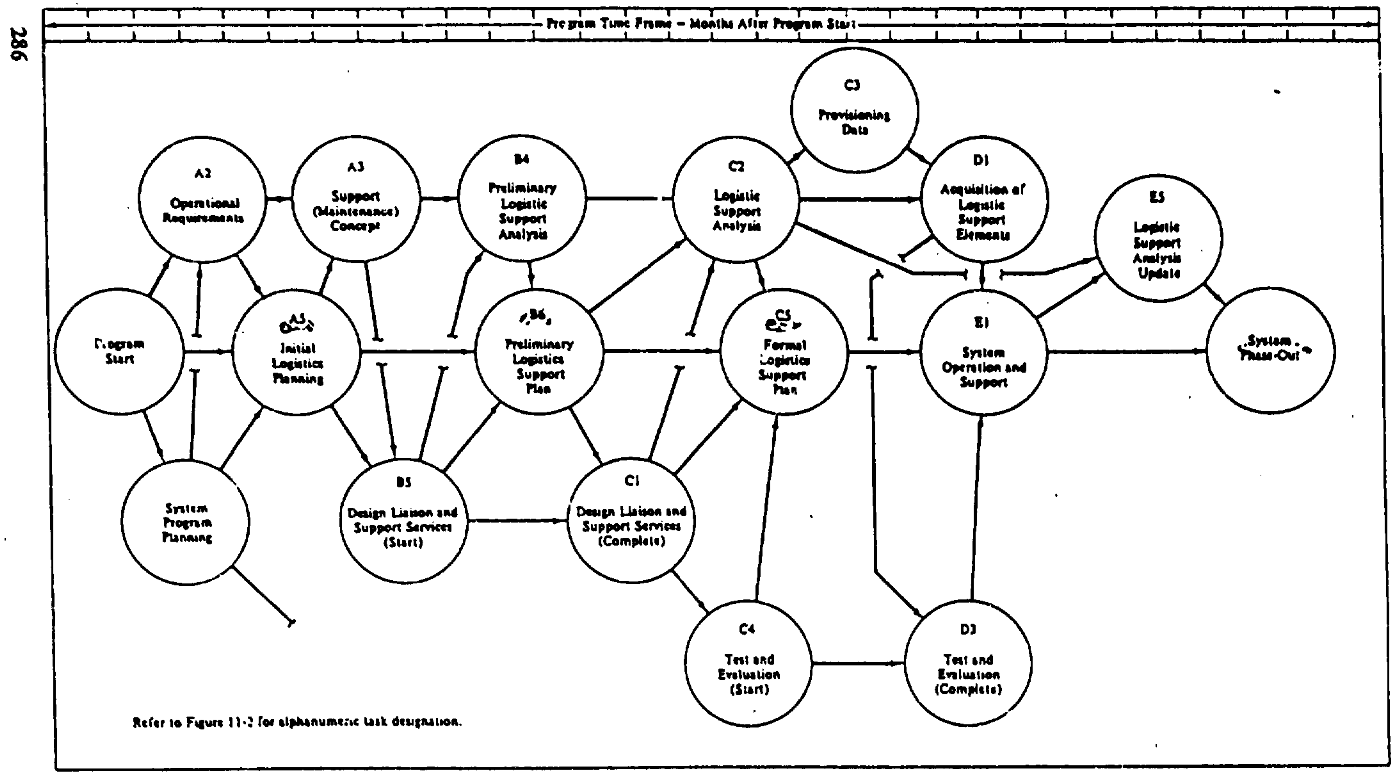
FIG. 10 TYPICAL PROGRAM TASKS FOR LOGISTIC SUPPORT

(SOURCE: LOGISTICS ENGINEERING AND MANAGEMENT, BY PROF. BEN BLANCHARD, PRETICE-HALL, 1974)



F I G. 11 SYSTEM LIFE-CYCLE PROCESS

(SOURCE: LOGISTICS ENGINEERING AND MANAGEMENT, BY PROF. BEN BLANCHARD PRENTICE-HALL, 1974)



F I G. 1 2 P A R T I A L S U M M A R Y P R O G R A M N E T W O R K

(SOURCE: LOGISTICS ENGINEERING AND MANAGEMENT, BY PROF. BEN BLANCHARD, PRENTICE-HALL, 1974)

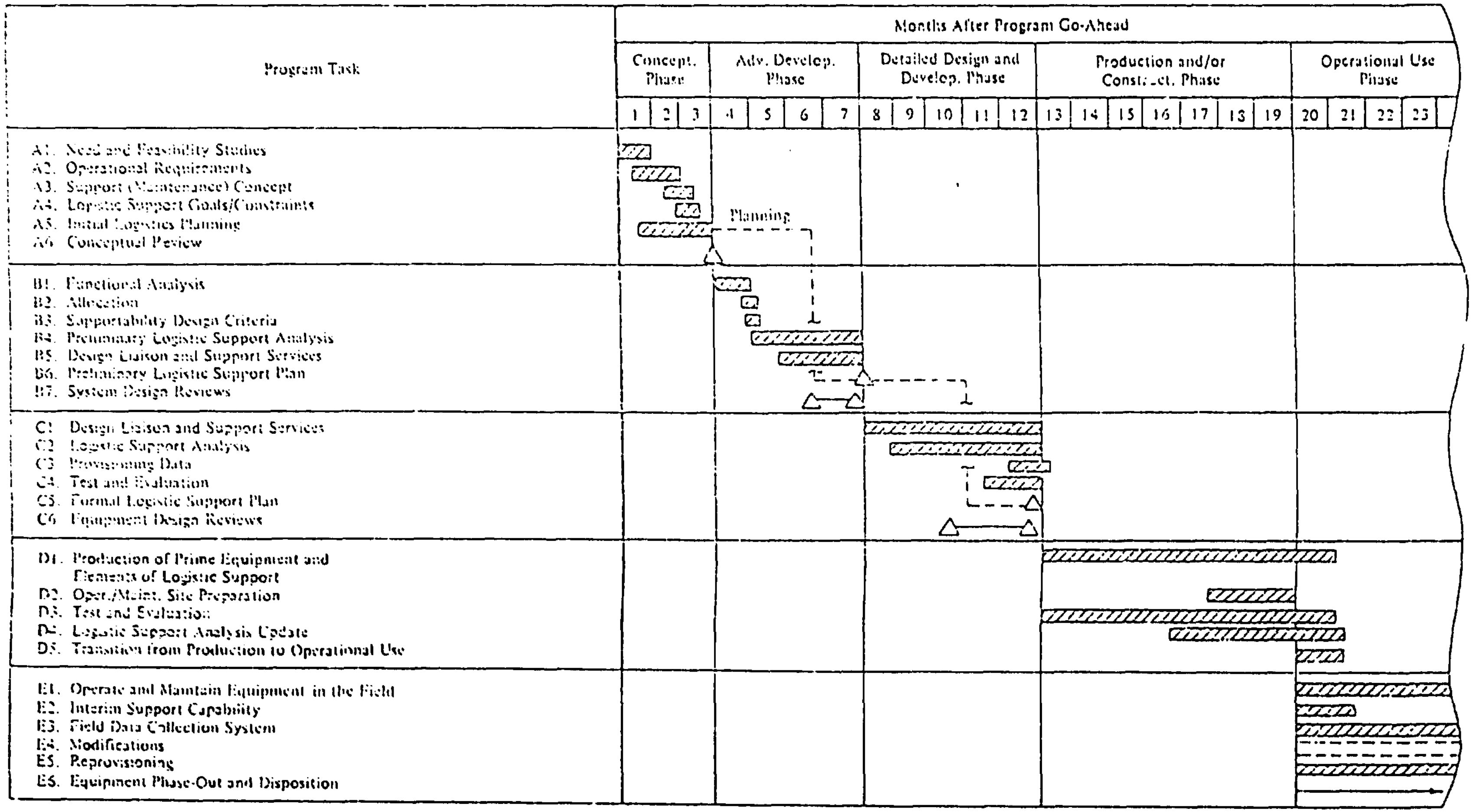


FIG. 13 BASISC MILESTONE

(SOURCE: LOGISTICS ENGINEERING AND MANAGEMENT, BY PROF. BEN BLANCHARD PRENTICE-HALL, 1974)

A) SUMMARY LISTING OF SPARE/REPAIR PART AND CONSUMABLE REQUIREMENT BY TYPE OF MAINTENANCE LEVELS.

B) ACQUISITION PLAN. FOR NEW (NON-STOCKLISTED) SPARES AND CONSUMABLES FOR PRIME EQUIPMEN, TEST, AND SUPPORT/HANDLING EQUIPMENT AND TRAINING EQUIPMENT.
THIS MUST BE CONSIDERED MANUFACTURING TEST APPROACH, PRODUCTION CONTROL QUALITY ASSURANCE PROVISION, AND DELIVERY REQUIREMENTS.

C) ACQUISITION PLAN FOR COMMON STANDARD (STOCKLISTED) SPARES AND CONSUMABLES FOR PRIME EQUIPMENT, TEST AND SUPPOORT/HANDLING EQUIPMENT, AND TRAINING EQUIPMENT.

D) WAREHOUSING AND ACCOUNTABILITY FUNCTIONS ASSOCIATD WITH MAINTENANCE SSUPPORT. THIS NOT ONLY INCLUDES THE INITIAL CATALOGING, STOCKING, INVENTORY MAINTENANCEAND CONTROL, PROVISIONING CYCLLES, BUT ALSO COVERS THE DISPOSITION OF RESIDUAL ASSETS.

E) A PLAN FOR DATA COLLECTION, ANALYSIS, AND THE UPDATING OF SPARE/

REPAIR PART DEMAND FACTORS NECESSARY TO IMPROVE PROVISIONING CYCLES AND REDUCE WASTE.

FIG. 14 IS INDICATED FOR SPARE/REPAIR PARTS DEVELOPING PROCESS.

7-3 ORGANIZATION FOR LOGISTIC SUPPORT

THE TYPICAL LOGISTIC SUPPORT ORGANIZATION IS SHOWN AS IN FOG. 15. SUCH INDEPENDENT RESPONSIBILITY ASSIGNEMENT HAS SEVERAL ADVANTAGES;

A) ASSIGNED PERSONNEL ARE TOTALLY COMMITED TO THE PROJECT. THEIR ATTENTION IS UNDIVIDED. MOTIVATION IS ORIENTED TO THE PROJECT (EACH INDIVIDUAL HAS ONLY ONE BOSS), AND THEIR KNOWLEDGE OF PROJECT PROCEDURES AND THE CUSTOMER IS FAIRLY EXTENSIVE.

B) THE COMMUNICATION LINK BETWEEN PROJECT PERSONEL AND BETWEEN THE PRODUCER AND CONSUMER ORGANIZATION IS USUALLY GOOD SINCE THE ASSIGNED PERSONNEL HAVE IN ALL PROBABILITY BEEN WITH THE PROJECT SINCE ITS IN-

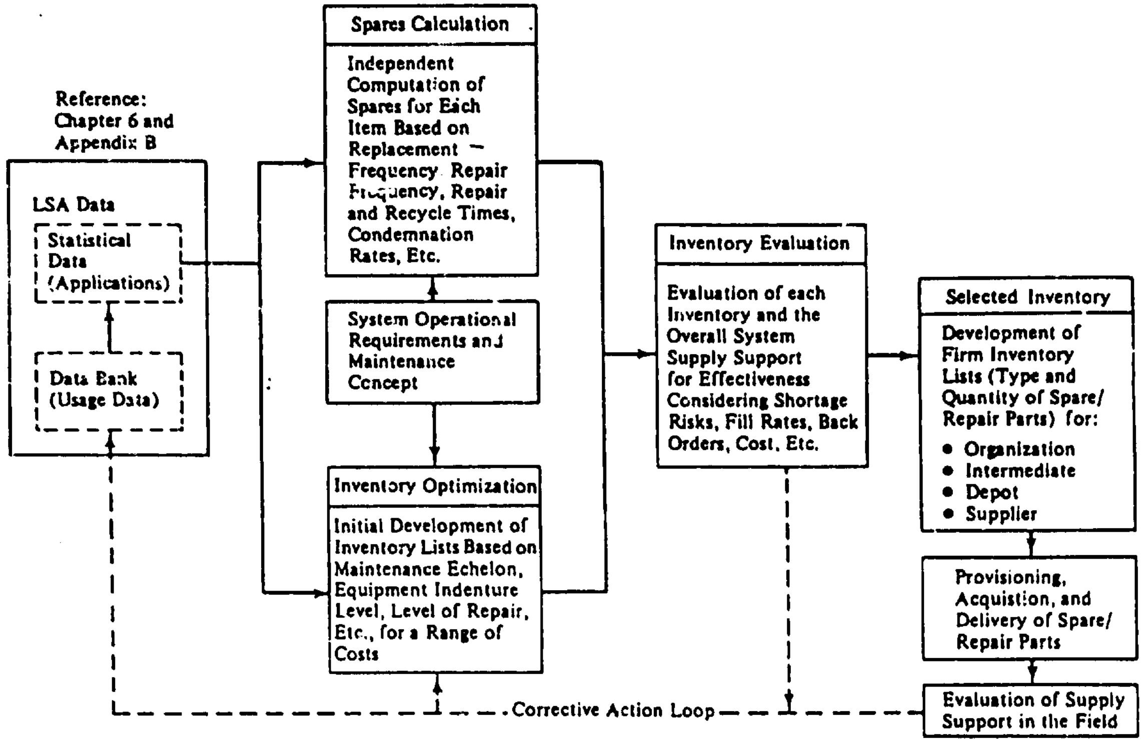


FIG. 14 SPARE/REPAIR PARTS DEVELOPMENT PLAN

(SOURCE: LOGISTICS ENGINEERING AND MANAGEMENT, BY PROF. BEN BLANCHARD.

CEPTION. THIS IN TURN AFFECTS. THE QUALITY OUTPUT OF A GIVEN TASKS.

C) ASSIGNED PERSONNEL ARE GENERALLY QUITE FAMILIAR WITH THE SYSTEM/EQUIPMENT REQUIREMENTS. DESIGN CHARACTERISTICS. ETC., AND ARE IN A FAVORABLE POSITION TO MAKE THE NECESSARY DESIGN AND SUPPORT DECISION.

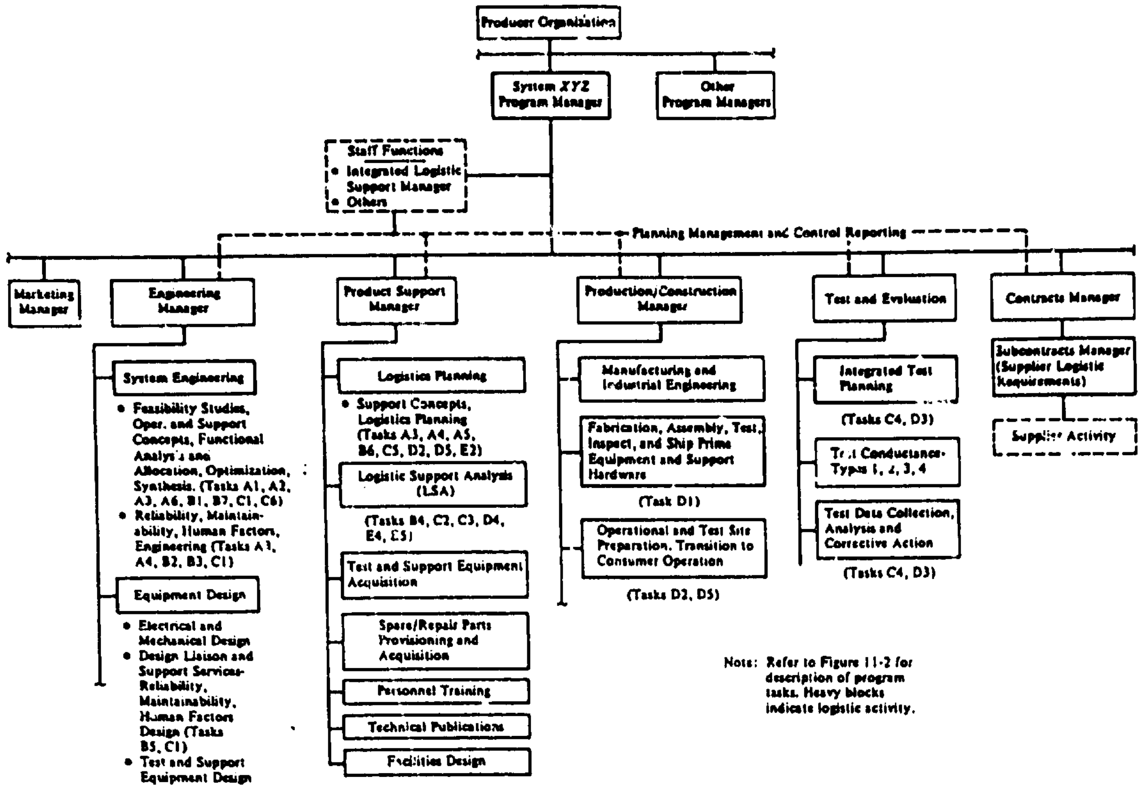


FIG. 15 PRODUCER'S LOGISTIC ENGINEERING ORGANIZATION

(SOURCE: LOGISTICS ENGINEERING AND MANAGEMENT, BY PROF. BEN BLANCHARD PRENTICE-HALL, [illegible])

Technology Development and Transfer

by Hajime Karatsu

Director, Tokai University

Technology Development and Transfer

Hajime Karatsu, Director, Tokai University

Japan's Technology Transfers Are for the Invigoration of the World Economy.

It is natural that people want to incorporate Japanese technology and product strategy, which has been so very successful, in order to invigorate their own countries' economies. There are many voices calling for technology transfers from Japan for just this reason. The Russians say that they are more interested in technology than in capital, and the reason I was summoned by the South Korean government in August (1991) was to discuss technology transfers.

It goes without saying that the starting point of the Japanese economy is production. A while back we envied countries that possessed an abundance of natural resources, but the real value comes from having the technology to process resources. Resources without the technology to process them are nothing but worthless gravel.

Japan built its strong economy by buying resources as cheaply as possible, processing them, and thereby adding value to them. This is a principle that everyone understands, and it has lead more and more countries to want Japanese technology.

However, in many cases the people involved in negotiations have absolutely no idea of what technology is, so the resulting talks do not go smoothly. Our goodwill is interpreted as insincerity and sometimes even becomes the basis for disputes.

Basically, technology is the business of producing things. But just the fact of having produced something has no intrinsic value. If what we produce is not something that customers will buy willingly, the result will be nothing but a large stockpile of unsold merchandise. It is necessary first to decide what and how much of it we will produce, and how we will go about selling it. There is also the matter of collecting capital. If all of these elements do not go as planned, our attempts at production will have failed.

Putting the question of production aside for the moment, the reason the Russian economy deteriorated is that distribution was poor.

What's more, technology is constantly advancing, and competing products will always appear. China and other countries export the products they make using technology introduced from outside, attempting thereby to defray the cost of the technology. But in fact, they have a difficult time of it. When trying to sell a product, it is impossible to keep up with one's rivals and push ahead of them amid international competition, unless careful attention is paid to aspects such as quality, quantity, and delivery schedules.

In order to accomplish this goal, it is indispensable to organize the training of managers, the education of engineers, etc., so that it all functions smoothly. However, these are management tasks, and it is difficult if not impossible simply to adopt Japanese management methods 100 percent. This being the case, we try to persuade the other side that bringing the parts and materials from Japan and processing them is the key to success, but the insistence of the local people that they want to do everything themselves cannot be changed. They are laboring under the misapprehension that technology is something that can be packed into a cardboard box and taken home, and that it will then work as soon as it is unpacked.

In fact, things don't move forward that easily. But no matter how carefully we try to explain this point so that the other side will understand, they just don't seem to get it. When we propose technology suitable for local conditions, we always receive the stubborn reply: "No, not that! We want the most advanced technology." When we say that is not possible, they start to get angry, saying they've been insulted.

When disputes of this sort arise, we also act foolish and feel like telling the other side to drop dead. There are countless cases of technology brought from Japan that has been left to rust and fall apart due to disagreements of this sort.

I feel that the way to break this vicious circle is to establish local free zones. Here the laws and customs of the host country would be disregarded completely and everything would be done exactly as we directed. In other words, we would create mini Japans. We would ask for no input with regard to training or management. Once things were running smoothly, these free zones could be handed over to the locals one after another.

This would be a quickest way to do the job. If things were done ineptly and local people given administrative positions, they would interfere with their superior's plans and nothing good would come of it. There is no other way of transferring Japanese technology unmodified.

When I proposed such free zones at the Japan-U.S.S.R. round-table discussion held in Moscow in 1989, everyone expressed enthusiastic agreement. However, when I returned to Japan and discussed the issue with the economic critic Keitaro Hasegawa, he said the proposal was no good. You never know what was going to happen in the Soviet Union. Doing things ineptly would be like throwing money down the drain.

This led me to think of a new plan. How about buying up some of the used tankers that are now glutting the world market? An entire factory, such as an electrical generating plant for example, could be housed in a single vessel. The result would be a floating factory. Once the factory was complete, people from the host country could be sent to Japan to receive comprehensive training. The floating factory would then be sent to the host country as soon as everything was operating smoothly -- full production from that day forward. If the host country had any complaints, the ship could just return to Japan. This would eliminate the risk posed by the host country.

This is the surest and most foolproof method of technology transfer. Doesn't it seem like a sure thing for the technology transfer projects of the future?

But in fact, even if Japan could just move a factory to its destination and then relinquish it to the host country, there is no way of knowing whether it would then be able to maintain its competitiveness.

This leads me to explain the necessary process in the following way. There are three steps.

Step (1) Knowledge

Knowledge can be written on paper, and it is generally thought that if you obtain it you can make products. But in fact, there are many things that cannot be explained using logic alone and many products that cannot be manufactured without taking the workers by the hand and giving them careful training.

Step (2) Knowhow

Here I am speaking of the little tricks needed to get the knack of something. In some cases, it may be necessary to remember the necessary skills with one's body as well as one's mind, so that they become second nature.

There are cases where trainees are invited to Japan and after progressing to this stage return to their own countries, where they promptly become managers and lord it over the others in their offices. But this is no way to make good products. In the case of developing countries, particularly, this area is a key condition that can determine overall success or failure.

At this stage a factory can operate and things will be produced. But an actual factory is very difficult to manage. Unanticipated problems crop up one after another. There is no assurance that the raw materials will be delivered every day. The condition of the machinery can also change. Then there is the turnover of workers. There really is no limit to the problems that arise. This is why the next step is necessary.

Step (3) Improvement

Unless management is actively working to spot problems as they arise and skillfully solve them, the factory will operate in fits and starts and it will become impossible to produce anything.

Therefore, only when knowledge, knowhow, and improvement function properly can technology transfers succeed. This means that unless the daily activity of management is devoted to the last step -- improvement -- success is not possible.

Furthermore, there is the issue of technical development. Since the pace of technical development is so fast, it is not unusual for the equipment transferred as part of a technology transfer to already be somewhat out of date when the transfer takes place.

When this happens, the other side becomes angry. "You sold us old technology!", they say. But the equipment was probably state of the art when the contract was signed. Therefore, unless the host country is capable of developing new technologies one after another, they will fall behind and lose their competitiveness.

I hope it is understood that both sides will come away feeling dissatisfied unless technology transfers are based on careful plans that take into account the points we have just discussed.

At this point I would like to discuss in an organized manner what I consider to be the important points regarding technical development.

The "Technological Free Ride Theory" Is an Empty Theoretical Abstraction.

So many conflicting things are said about Japanese R&D that it is difficult for a third party to figure out which are true.

One that is often heard is the technological free ride theory, which goes like this: "Even though the Japanese may talk big, most of their ideas are borrowed from abroad. This is proven by the low number of Nobel Prizes they have won." Then there is the theory that makes Japan out to be a technological giant: "Of the ten companies awarded the largest number of United States patents in 1990, five were Japanese." "Lately, the number of parts and machines that can be supplied only by Japan is growing. This is one reason why it is difficult for Japan to reduce its trade surplus." Neither of these theories is completely untrue. However, from my point of view as one familiar with the places where technical development takes place, I cannot help but feel that each of these views focuses on only one tiny aspect of the technical development process.

The starting point of Japan's economic might is, needless to say, her production capabilities that make it possible to supply superior products to the world before her competitors do. But even if we consider this aspect alone, Japanese technology is world level and it cannot be said that it is second rate.

The fact is that technology is really production, basically. This means that you can see clearly how good the technology is by looking at the finished product. Even if one objects that "they just took the basic ideas from somewhere else," the fact is that if you have only ideas but can't turn them into products, you can't really say you have technology.

One technology that succeeded in Japan is the rotary engine. The idea for the rotary engine was conceived in Germany, but the only company to succeed in mass producing such engines throughout the world is Mazda. Germany, where the idea originally came from, couldn't turn it into a practical product. One cannot claim to have succeeded in developing a technology on the basis of ideas alone.

In order to succeed in the development of technology, the first stage is the conceptual one where you decide what to make. This stage is important, but there are many other essential conditions. Only after succeeding in a number of steps -- production technology issues (how will we make it?), marketing (how will we sell it?) --does the technology assume a real place in the business.

Leonardo da Vinci was a marvelous idea man. The countless sketches he made to illustrate his ideas can still be seen today in a museum in Milan. But if these ideas are taken up in our own age and turned into real products, we can't say that the technology was invented by da Vinci.

If it were possible to make products out of ideas alone, no one would have to work very hard. The idea of flying is one that has been around since long before da Vinci's time.

The job of production is very important. It comes about through a bringing together of nearly limitless materials, processing, and assembly knowhow. And it requires difficult and precise technical skill, that cannot be written down.

From the point of view of the site where the work necessary for production actually takes place, the Japanese technological free ride theory looks like an empty theoretical abstraction. It makes me want to say to its proponents: Go ahead and try to do it yourself if you think you can!

The electronic weaponry that America made such wide use of in the Persian Gulf War contained many gallium arsenide semiconductors. Most of them were made in Japan.

The basic principle of the gallium arsenide semiconductor is widely known and can be found in many textbooks. But only Japan can make them. Most semiconductors are made of silicon, but the especially fast ones and the highly sensitive ones that handle very small signals are made of gallium arsenide. However, gallium arsenide is more tricky to handle than silicon and requires special equipment. This equipment is very expensive and requires a special technique to operate. This is precisely the production technology that was developed in order to mass produce the laser diodes for the compact disc players that Japan is so good at making. In other words, in this case a military product has been helped along by a Japanese consumer technology.

A recent issue of Business Week also points out the importance of production technology. It contains a list of parts and materials for which Japan is almost the sole supplier and analyses why these technologies were not developed in the United States. It gave as the reasons the problem of a short-term management climate as well as lateness in developing advanced technology driven by the enormous consumer market. I wish to point out that this is a different dimension from issues peculiar to technical development. It is also mentioned in the material on industrial policy distributed by President Clinton during the election campaign. Namely, that in many cases consumer technology is leading military technology. Furthermore, it is pointed out that the consumer field is ahead in the area of production technology.

Technical development cannot be properly evaluated unless it is viewed as a management issue. Technology is a different world from academia, where acquiring knowledge is the goal. No matter how many Nobel Prizes you have, that's not technology. It's not technology unless you can produce a product.

"Fuzzy Logic" Products Symbolize Japanese-style Development.

Technology is a game in which how large a market you can create is the key to winning. No matter how wonderful the principle it is based on, a technology will die if no one buys the finished product. After all, the reason technology comes into existence is to return the investment made in development, production, and marketing. Science is different with regard to this point. The aim of science is the acquisition of new knowledge, but technology is never free from monetary considerations.

These days, one announcement after another is being made with regard to evaluating the competitiveness of American technology in order to rebuild the U.S. economy. A look at these assessments shows that the United States is overwhelmingly dominant in the field of aviation, with jet engines at the top of the list. However, it is so weak in areas like silicon and ceramics, the material from which semiconductors are made that recovery seems almost impossible.

While looking at these comparative tables, I noticed something important. There is very little discussion of the scale of the economic impact that the various technologies are likely to create.

The scale of the aviation industry, in which America dominates, is no more than about 11 trillion yen. In contrast to this, automobiles, an area where the United States trails Japan in technology, is a 36 trillion yen industry. Just about the only large-scale industry in which the United States is strong technically is chemicals. The steel industry has weakened so much that it would probably disappear without support from Japan, but it accounts for about 10 trillion yen. The Japanese economy is strong in industries with enormous markets, and it is strong in these industries due to technological prowess.

The reason things have gotten this way seems to be a difference in our attitudes toward technology.

The other day, a forum was held on technical development with the aim of improving the relationship between Japan and the European Community (EC). At this forum the Japanese side explained the technologies on which it would like to cooperate with the Europeans in the future and the prospects for those technologies. At this, the Europeans responded, "but aren't those all industrial technologies?" The Japanese side had intended to make a proposal regarding consumer technology, but it became clear that the attitudes toward technology of the Japanese and the Europeans were quite different.

When a new technology is created in Japan, the first thought is always about how to incorporate it into something people can use. And attention always tends to focus on the consumer

market, with its large market scale.
On the other hand, in Europe and America there is always the fixed notion that military applications come first and industrial applications second. Because of this, they are always unable to catch up with the Japanese way of doing things, and in the end they are not up to the challenge. From the start, they are fighting the battle in a different arena.
The microprocessors used in the Patriot missiles that were used extensively in the Persian Gulf War were old third-generation 8088 processors. Since competition is fierce in the consumer market, old technologies are immediately discarded as soon as something even a little bit newer appears. However, in the military field, development is very time consuming. And even when something is finished, it still has to be distributed to all of the different units and the personnel must be trained how to use it. This means that it is even later that it can actually be used in battle. This is why this topic of discussion came up.
The Americans and Europeans seem finally to be waking up to this fact. Nevertheless, the military is not a large market in Japan, so new things tend to be applied first in the

consumer field. This is one of the reasons that Japanese products have overwhelmed the United States and Europe. However, a more important point is that production volumes are small for military items. Production of airplanes, for example, is less than 110,000 units per decade (assuming it is not wartime). On the other hand, production of automobiles is often around 10,000 units a month. This means that even if the same type of engines are being produced, the production technology involved will be two different things altogether.

After the collapse of the Soviet Union, an attempt has been made to convert military technology for consumer use, but things are not going well. One reason for this is the difference in volume. The Russians seem to have thought that if they could make tanks, making cars and tractors would be a snap. But making cars and tractors is a whole different world.

In contrast, in Japan the latest advances in high technology are used in the consumer field. It is not unusual for such technologies to find there way into industrial or military applications only afterward. This goes to show that the concept behind the term "dual use technology," which is used

in the United States, is in fact behind the times.
In this regard, the United States is busy sowing the seeds for all sorts of new technologies that they call the high tech of tomorrow. But the example applications that we hear about are mainly complicated military or industrial ones. But invariably in Japan, different sorts of applications from those discussed by the Americans are developed.
The "fuzzy logic" washing machine, for example, is an application that the people who developed fuzzy logic theory never envisioned. Fuzzy logic is an academic theory that was conceived more than 20 years ago at Stanford University in the United States. In those days, perhaps partially due to the meager capabilities of computers, it attracted little notice. Then it became possible to build low-cost and light fuzzy logic systems thanks to advances in microprocessors and sensors, and eventually such systems were incorporated into fully automatic washing machines. This achievement is symbolic of the Japanese style of development.

In the Patent War, Attack Is the Best Defense.
-- The resolution of the Minolta patent infringement case

A recent news story reported that Minolta Camera Co. was to pay a settlement of $127,500,000 for patent infringement. This led to all sorts of introspective talk about the creativity of the Japanese. But this kind of talk is completely irrelevant to the issue. Some are of the opinion that an attack on Japanese manufacturers based on intellectual property rights has begun. But this talk about patents deals mainly with old patents soon due to expire when their 20-year terms run out. When these patents were issued, Japan had no technical development capability, so nothing can be done about it.

But the one's feeling the pain now with regard to patents are the American and European enterprises. These days the patent onslaught from Japan is fierce. Last year (1991), five Japanese companies were among the top ten awarded the most patents in the United States.

Generally speaking, it takes from five to ten years for patents to be developed into products that we can buy. This means that the flurry of patents being issued to Japanese manufacturers are like a time bomb. Before long the sides will change places, and we will see the American and European manufacturers in a tight spot.

One of the hot topics in high technology recently is superconductivity. After high-temperature superconductivity was discovered, Japanese manufacturers unleashed a deluge of patent applications. It is even said that one company alone was responsible for more than 1,000 applications. Therefore, when products using superconductivity finally become practical, it is though that the Japanese patents will have the prize firmly bound up.

There is only one way to fight a patent. Japan must obtain as many patents as possible. Attack is the best defense. And we must enter into contracts that allow joint use of joint patents without fee. This is what is referred to as cross licensing. When Japan began manufacturing color television sets, the American company RCA held all the patents on the technology. Japan had to pay large patent licensing fees. But when the situation of the other European TV manufacturers was investigated, it turned out that almost none were paying such fees. They had cross licensing arrangements with RCA.

The American and European electronics manufacturers boasted a long history up until that time, and they held many key patents themselves. For this reason they had comprehensive contracts with RCA that allowed both sides to use each others patents for free. It may not be apparent on the surface, but all the Japanese manufacturers have cross licensing agreements with overseas companies. If they didn't, they could not survive. But once you get into the cross license club, you have nothing to worry about.

It is not all that long ago that Japanese manufacturers finally were able, in the real sense, to get their hands on tickets to the cross license club. This is why they had to suffer from the old patents up to that time.

On the other hand, the Japanese patents that have really paid off are in the field of video. Receipts of patent licensing fees from the patents on the VHS specification, which has become the world standard, can sometimes amount to as much as 15 billion yen per year. The amount is as large as it is because of the high price of VCRs and also the large volume produced.

This shows how frantically Japanese enterprises are working on technical development. Last year, investment in development topped 10 trillion yen. That's because this investment will determine each company's future fate. Some electronics manufacturers devote more than ten percent of their sales revenues to R&D.

At any rate, when one hears the term intellectual property rights, it is easy to assume that the issue is as clear-cut as it is with property rights regarding merchandise. But in fact intellectual property rights are an entirely different world.

Basically, when we say creativity it is common to conjure up an image of making something out of nothing. But in fact, things are not created out of nothing. What an inventor does is to combine what was previously known in a new way to create a new discovery. This means that there will always be some gray areas with regard to the boundary between what is old and what is new. And the final arbiter is the court. This means that each side's ability to argue its case is the key to who will come out on top.

I once chaired a panel discussion that was part of an international conference on intellectual property rights held in Tokyo. As part of the opening remarks, I showed four slides. They were satellite photos of the site of the explosion at the Chernobyl power plant. The first was from the American Landsat satellite. It had good resolution, but since it was in black and white it was a very monotonous image. The second was from the French SPOT satellite. This one was in color so it was clear that the colors in Chernobyl seemed abnormal. I then showed an enlarged version of the second photo, but its resolution was poor and everything appeared fuzzy. Then I showed a computer generated composite image produced by combining the Landsat photo and the SPOT photo. In this case it was quite clear that an accident had occurred.

I gave an explanation as I showed the four slides. America owns the intellectual property rights for the black-and-white photo, and France owns the rights for the color photo. Neither of these images clearly showed that an explosion had taken place. But who owns the intellectual property rights for the composite image? When we began the discussion after this preface, the panel members who had been rather worked up became rather reticent to speak. I remember that it threw a damper on the whole discussion.

One of the big topics regarding patents in 1992 was Minolta's agreement to pay Honeywell a large patent licensing fee. But in many such cases, Japanese firms lose because of the American jury trial system. Therefore, this case has absolutely nothing to do with how creative the

Japanese are.

In any case, the recent patent offensive by the Japanese is becoming a real menace to the Americans and Europeans. But this is an indispensable condition for Japan's ability to continue to tread the road of future survival. Either skillfully evade the old patents, which are beginning to expire anyway, or enter into cross licensing agreements. And at the same time continue applying for more and more patents for tomorrow's sake. This is the strategy that every company has in mind.

Washington Is Not America.

In a baseball game, imagine that the batter hits the ball and suddenly runs to third base. When he is tagged with the ball, he insists that he is not out. If things went like this, the result would no longer be baseball. It would be some other game. But recently, America has taken to changing the rules one after another to suit itself as soon as the game gets underway. It then acts as if this is just to be expected and comes out with one theory after another to prove it.

The other day, through some farfetched argument it was ruled that Honda was evading taxes on its Canadian-built cars, even though they are equipped with engines built in good old Ohio, U.S.A.

And until recently, America was brandishing local content laws in an attempt to coerce Honda to produce their products in the United States. No sooner were the words out of their mouth than this happened. At any rate, it is amazing that Japanese public opinion is so silent on this matter.

If a European manufacturer were treated in this way, things would not have blown over so easily. It would have become a major issue between the nations involved. Japan has been made to look a complete fool. And the ones who have been standing up for Honda are the Canadian government and Canadian public opinion. This is a totally bizarre situation. It would seem that this sort of thing is just too trivial for the so-called intelligentsia in Japan to bother with.

In the end, this is a case of the American Antimonopoly Act being applied outside of U.S. jurisdiction. It is an attempt to punish a Japanese company for not complying with American domestic laws in Japan. For this reason, it seems natural that there can be no prosecution unless evidence is gathered inside Japan. Do the American prosecutors intend to pursue their own investigation in Japan? This would be a clear violation of national sovereignty. It is said that some countries have passed laws prohibiting foreign prosecutors from conducting investigations in order to prevent just such incidents.

When a Japanese company is indicted, a failure to produce proper evidence will be to that side's disadvantage at the trial. Even so, the Japanese side cannot conduct an official investigation according to American law. This goes against the principle of fairness.

If they are going to announce this kind of unrealistic, problem-filled, half-baked, one-sided Justice Department ruling, then one has to say that Washington has sunk about as low as it can go. But this is a country that could go and capture General Noriega of Panama in a country outside of U.S. jurisdiction and then go and find him guilty. From this point on there was no saying what might happen.

Nevertheless, these days magnificent reports are coming out one after another in America on how to revitalize the U.S. economy. There have even been real masterpieces such as "Made in America," which was published the year before last (1990) by the Massachusetts Institute of Technology (MIT) and also issued in translation in Japan.

The general direction was indicated last year (1991) by the Committee to Increase Competitiveness, mainly with regard to the technological aspects. Then this year (1992) as well, a report to the President was issued in March. Many of the points it covers, such as the low rate of savings, were already general knowledge. But reading this report one realizes that thoughtful people in America are giving very serious consideration to the question of what is necessary for revitalization and proposing that appropriate measures be implemented. I would like to draw attention to the fact that the common emphasis is centered in the question of how to solve America's internal problems, and that there is no Japan-bashing talk at all.

When Japan is discussed in these reports, it is as an example of success. Japan's strengths -- the high educational standards, the long-term outlook of Japanese management, the willingness to invest in R&D -- are sited and used to urge the American people to do better.

In addition, these days there is a never ending succession of observation groups from America coming to learn Japanese management techniques. In Japan it is assumed that the Americans think that the keiretsu system in Japan is a bad thing, but in fact the opposite is the case.

In the January 27 (1992) issue of Business Week, there is a feature article entitled "Learn From Japan -- Keiretsu." Compared with people familiar with this serious view, which could be called a plea for honesty, it is Washington that seems abnormal. One gets the impression that they inhabit a completely different world. They think that it is acceptable to go and change the rules if it will win them a few points.

One begins to suspect that they think that they wouldn't score if instead they abided strictly by the old rules.

We must Recognize Anew the Prowess of the Japanese Manufacturing Industry.

As the economy worsens in the United States, one proposal after another appears on improving competitiveness of American industry. A number of serious and earnest reports have come out, including "Made in America," a thick report issued the year before last (1990) by the Massachusetts Institute of Technology (MIT) and then later published in translation in Japan, where it attracted considerable attention, last year's (1991) report by the Committee to Increase Competitiveness, and this year's (1992) recommendations from the Council of Economic Advisers. Reading between the lines in these reports, Japan's strength can be perceived. And when I looked at the comparative tables showing the competitiveness of various industries, I noticed something important. Namely, the industrial fields in which America is overwhelmingly superior in technology are fields with surprisingly small markets.

Aerospace is said to be the field in which the United States is strongest, but the scale of this market is smaller than one would expect. Airplanes alone count for about 10 trillion yen, including military aircraft, and when space related items are added the total comes to only 13 trillion yen. However, automobiles, a field where America has taken a bruising from Japan, is an enormous industry worth more than 36 trillion yen. The steel industry would hardly be able to survive if it did not ask for import restrictions against various countries, but it amounts to only about 9 trillion yen. This is about the same level as aircraft.

If one examines technological prowess and industrial scale in this way, the only really large scale industry where America has an overwhelming technical advantage is chemicals, which is worth more than 30 trillion yen.

America is said to be the clear leader in computers, but since much of the actual production is done offshore, domestic U.S. computer production (including software) comes to less than 20 trillion yen. Perhaps because of this, Business Week has predicted that Japanese production will probably exceed domestic U.S. production by 1998.

This makes one of the causes of the American tragedy clear:

the relative decline in technical prowess in the fields with the largest markets.

Basically, the starting point of any economy today is production. A while back talk about the shift to a service-based economy and the increasing importance of software was quite popular. This led to the delusion that software could produce a bigger economy than the production of hardware. But one should compare the value of the goods produced by the various industries in the Japanese economy with the added value they create. Production industries are the overwhelming leaders.

Recently it seems that this fact is finally being understood. But there is another misunderstanding that remains. The term "high tech" is bandied about too often. This second misunderstanding is the idea that as long as companies are involved in high tech, the economy will have smooth sailing in the years ahead.

It goes without saying that the problem here is the core of the term "high tech" itself. Industries such as the traditional steel and textile industries that grew up since the Meiji period, as well as shipbuilding, are grouped together under the term "heavy industry." This gives the impression that they are the industries of the past. This is not so much a ridiculous misunderstanding as an absurd theory. Japan's computer industry, including software, accounts for 16 trillion yen. But the steel industry is worth 17.2 trillion yen. Chemical engineering is a representative "heavy industry," but it accounts for 22 trillion yen of which 11 trillion yen is added value, making it an amazingly efficient industry as well. Automobiles is a large-scale industry worth 42 trillion yen, of which only 12 trillion yen is added value. This should make clear just how efficient the chemical industry is. Textiles, including apparel, account for 17 trillion yen. But the public thinks of these industries dismissively as typical of the "three D's" (dirty, dangerous, demanding). So young people are not drawn to them. This will become a big problem affecting Japan's future.

Happily, the bubble has burst. I believe that now is the best possible opportunity to let people know what really supports the Japanese economy.

A salient feature of Japanese society is its flexibility. If we think that something is no longer useful, we forget about the past and strike off in a new direction. Viewed from abroad, we may appear lacking in fixed principles or unreliable, but we don't care. Truly, "wise men are quick to adapt themselves to circumstances," as they say.

The former Soviet Union collapsed because, believing there was only one ti ıth, they stubbornly clung to one orthodoxy and the political system became ossified.

Progress is something that is always changing. As long as we retain the flexibility we have maintained up until now, the Japanese economy will be fine. The industrial vision for the nineties compiled by MITI recently provides additional support for this claim.

German Industry Is Aiming for America.

According to an article in a recent issue of Business Week, German industry unable to ensure pressures at home, such as the world's highest wages, labor that calls strikes at the slightest provocation, and high corporate taxes, is beginning to move manufacturing facilities to the United States. It seems that the stories I heard when I attended a German symposium in early May (1992) were true.

In Japan, only Germany's short work hours are publicized, so

Germany tends to be considered a kind of workers' paradise. I had thought that this situation must be very difficult on management, and it seems I was right. By moving manufacturing bases to the United States, wages are reduced by 20 percent. And what's more, America is the world's largest market. A trade agreement has been signed with Canada, and talks are underway with Mexico. Even more attractive, an abundant supply of skilled engineers is available. Since 1985, the dollar has dropped to half its previous value. Stocks are cheap, and this is an ideal time for corporate acquisitions. Then the plans for production in America of the well known automobile manufacturers Mercedes-Benz and BMW, and the electrical appliance firm Siemens were announced in Japan all at once.

Both cars and electrical appliances are international products. So from the company's point of view there is no particular obligation to build them in their own country. If they do not manufacture their products in the most advantageous places in the world, they will loose ground to their competitors and find themselves in a precarious position. So if government ignores the basic principles of management, blithely continues to increase the tax burden, and pushes only for the workers' side of the argument, corporations will look for other places where they can run a business and leave their own country.

America has also been blinded by the lure of low wages and set up innumerable factories in places such as Mexico and Southeast Asia, thereby weakening the foundation of the U.S. economy. This is what is referred to as the hollowing out of industry. For this reason the share of manufacturing industries as part of the economy as a whole has dropped to 24 percent in the United States. This is really terrible when compared to the figures for Japan (34 percent) and Germany (37 percent). This is why imports to the U.S. keep increasing, and also the context for the German move.

Leaving aside the question of wages in America, it is interesting to note that what caught the interest of the Germans was the United States as a source of engineers, etc. For this reason they are settling down in the U.S.A. and are on the lookout not only for American corporations, but for people as well. This is not a reason one often hears as a motivation for Japanese companies' decisions to set up factories in America.

The most important thing for Japanese industries, which have grown to enormous size, is the question of how best to select personnel, money, and goods, and incorporate them into their organizations as management resources for the future. Those companies that are unable to adopt a multifaceted philosophy in order to do this are likely to be left behind little by little.

A management climate in which a call for shorter work hours grows all of a sudden into a great chorus throughout Japan calling for shorter hours is a dangerous thing. An economist I met in Germany said that one of the reasons for the plans to move to the U.S. was the extremely short work hours in Germany.

It Is Through Manufacturing That the Economy Is Strengthened.

The other day I visited a Nippon Steel Corporation plant. Since it had been a while since I had been to such a facility, I asked to be given a very thorough tour. When I went to the pier where the ships dock, a freighter with a capacity of 300,000 tons of ore was being unloaded.
When I asked, "How much does one ton of ore cost?", I was told, "About 10 dollars."
"Oh, I see," I thought. This iron ore is the raw material that is mixed with coke and lime, heated in a blast furnace, and then turned into steel in a converter. Steel costs between 50,000 and 80,000 yen per ton. Even if we think of look the cost of materials in terms of the yield rate, it still comes to around 3,000 yen per ton. Once these raw materials have been turned into steel, they are worth approximately 20 times that. The added value from processing is just phenomenal.
This steel can then be used as a material to make engines or cars. On a different day, I witnessed a test run of a giant 18,000 horsepower engine designed for use in ships. I asked

the same question: "How much does one ton of this cost?" The answer: 800,000 yen.

The added value from manufacturing is enormous. A while back, we envied the countries that have abundant natural resources. All they had to do was dig in the earth and all sorts of riches would come forth. We thought that Japan was a poor and pathetic country.

But the world has changed since then. All of the resource-rich countries are struggling. Since the technology for digging up resources has become very advanced, such resources immediately begin to be extracted as soon as they are found. But looked at in worldwide terms, demand for natural resources is pretty much set. The result is the inevitable collapse in the market for primary products.

The economic collapse in the former Soviet Union was also due to this. Ten years ago, 70 percent of the Soviet Union's export earnings were accounted for by oil. When the price of oil subsequently fell by half, oil's share of Soviet export earnings dropped to 40 percent.

When we consider something like this, it would seem rather to be a good thing that Japan has no natural resources to speak of. A look at market conditions shows us that prices for various commodities are changing all the time. However, the prices of industrial products stay relatively stable. So I feel that every country should depend on added value from manufacturing.

The economic white paper for 1989 provides statistics on the changes in the industrial structure in Japan after WWII. In 1957, Japan's largest industry was agriculture, which accounted for approximately 18 percent of the gross domestic product (GDP). At that time, the manufacturing industry accounted for approximately 16 percent of GDP. It can therefore be said that Japan was an agricultural nation. Thereafter, agriculture's share of GDP dropped, reaching about three percent by 1987. In contrast, the manufacturing industry grew rapidly, eventually reaching 35 percent of total GDP. This clearly shows that the manufacturing industry has been the driving force of Japan's economy.

On the other hand, the manufacturing industry accounts for only 24 percent of America's GDP. The Americans have given up on making things in their own country and shifted to overseas production. It is no wonder that their trade deficit has grown. In contrast, in the former West Germanv manufacturing accounts for 37 percent of GDP. This is the source of their formidable economic power.

However, since these facts are surprisingly little known, we sometimes here people coming out with completely ridiculous arguments.

Recently, as I was watching the morning newscast on TV, a well-known critic made the following statement:

"France? Well, France is above all an agricultural nation."

This is contrary to fact. Agriculture accounts for a little more than three percent of the French GDP, and the manufacturing industry accounts for 28 percent.

Are Canada and Australia industrial nations or agricultural nations? If you think about it, both seem to be agricultural nations, but the reality is completely different. In Canada, agriculture accounts for three percent and industry for 27 percent of GDP. In Australia, the figures are four and 26 percent, respectively.

It should be clear why all these countries put so much emphasis on the manufacturing sector. It produces a high degree of added value. The economy cannot grow if high-productivity industries do not grow.

When one considers these things, they seem to be almost self-evident. But the public at large only looks at the surface of things, and it is very unfortunate that there always seem to be people who say plausible sounding but erroneous things. We often hear of the growth of the service and software sectors of the economy, but I would advise you to take a look at how much added value these sectors really create. I expect that you'll find the figures to be quite different from what you expected.

The Undeveloped Wilderness in Japan

In California, in the United States, is a plant managed jointly by Japan's Toyota and America's GM. This plant was originally built by GM, but relations between management and labor were poor. There were frequent strikes, and GM had finally given up and closed the plant. When talk of a joint management venture with Toyota came up, GM proposed reopening the plant. Toyota had no objections. But it was also requested that all of the union employees from the U.S. auto labor unions, which had forced GM to close the plant once, be rehired. This made Toyota nervous, but they agreed thinking there was no alternative.

After plenty of preparation, the plant was reopened. The results were magnificent. The number of cars produced per worker, that is to say productivity, was twice what it had been when GM was managing the plant. It goes without saying that the quality of the cars produced was equivalent to that of cars imported from Japan.

America's Business Week magazine visited this facility and reported on it. It had been an established theory in the United States until then that the reason the quality of American cars had deteriorated and the reason costs were high was that the quality of American workers was poor. But a look at the results achieved at this plant showed that this theory was a superstition. The true cause was the different style of management that was practiced in the United States.

This success story was a big shock in American management circles. Until that time, one reason after another -- Japanese wages are low, Japanese workers don't mind working long hours and they work harder, etc. -- had been used to criticize Japan as an unfair competitor. But in this case, the astounding result of doubled productivity had been achieved on American soil and with American workers working under the same conditions.

But the odd thing is that news of this success has not be widely reported in Japan, and it is not evaluated highly except among experts. And as always, we still hear the arguments that the Japanese work too hard, that their lives are cramped and constrained, and on and on. The fact that, as a result, the totally baseless myth that the competitiveness of Japanese corporations comes from working employees in an inhuman way has taken root among the population at large is a very troublesome one.
This misunderstanding arises from the belief in the old canard that productivity is raised by making people work harder. The efficiency of Japanese corporations was not achieved by exploiting people. Japanese management practices are different.
After all, the term productivity has a definition. By increasing work hours it may be possible to produce more goods and thereby increase production, but this is absolutely not an increase in productivity. It is the opposite. Doing a job that used to take ten hours in a new way so that it can be completed in only five hours. This makes the work less demanding physically. Only when this is achieved can it be said that productivity has doubled.

In other words, raising productivity means having respect for the humanity of workers and making their lives more affluent. But still there are some people who think that increasing productivity is just another term for working harder. It is a fearful thing when people's ideas become set.

At any rate, you are probably wondering if I have any examples where things went the way I described -- cases where it was possible to accomplish the same amount of work easily in half the time. The basic principle is quite simple. First of all, one must mechanize. The Japanese manufacturing industry has many factories that are among the most productive in the world. One reason for this is the extensive use of industrial robots. Another important measure is developing the capabilities of human workers. If you train someone well and motivate them, they will be able to do twice or three times as much work efficiently.

The next important item is the management techniques for effectively combining the human and mechanical elements. The reason the plant jointly managed by Toyota and GM succeeded is clearly management techniques. The Massachusetts Institute of Technology in the United States has studied this issue and issued many reports on it. This is the same idea as the old Japanese saying that says you must know the correct way to use a tool, whether a kitchen knife or a pair of scissors, in order to get results.

These days many reports and commentaries are coming out comparing productivity in Japan and in Europe and the United States. But even though there are some areas, such as automobiles and electrical appliances, in which Japan shows overwhelming strength compared with overseas competitors, the view is widespread that productivity in Japan overall is low.

This view does not appear to be in error no matter where you get your figures from. And this leads to a question. In Japan, why is productivity low for a country as a whole while in some sectors a high degree of productivity has clearly been achieved?

The reason is simple. The productivity of some sectors of the domestic Japanese economy is low, and these sectors are pulling down the figures for the country as a whole. As I see it, this is a very good thing. It means that there is still an undeveloped wilderness of low-productivity areas in Japan that still have room for improvement.

These areas truly constitute a valuable untapped resource. By searching out and exposing these areas, Japan will be able to improve its standard of living enormously. What's more, we already know the way to accomplish this. We must all do our best.

The Technical Reliability That Money Can't Buy

The Japanese bullet train entered service in the same year the Tokyo Olympics were held. It has a sterling record. Though it may have experienced malfunctions, there never has been a serious accident. This is a quite unusually safe record when compared to the history of rail transport.

I was a member of the safety committee at the time when the plans for the bullet train were being drawn up. We were aware that should a train capable of traveling at 200 kilometers per hour ever have an accident, the results would be horrendous. So we examined all of the data from the past that was available and thought of countermeasures to deal with every contingency.

An examination of past railroad accidents showed that 60 percent of them occurred at grade crossings. So we eliminated all grade crossings on the bullet train line. If a train is traveling at 200 kilometers per hour and suddenly applies its emergency brakes, it will still continue to move for approximately two kilometers before coming to a complete stop. This meant that conventional signal lights would be completely useless. This lead us to develop a completely new traffic safety system involving, for example, the introduction of computerized CTC (centralized traffic control).

This arrangement that we were constructing consisted entirely of elements with which we had no previous experience. All of the equipment was built in the year before the bullet train went into service, then tested and retested. These tests revealed a variety of breakdowns and malfunctions in many pieces of equipment. At first, we wondered what the final result would be, but after solving one problem after another we managed, just before the train was scheduled to begin regular runs, to finish building a system that would allow safe operation at high speeds.

The academic field concerned with investigating equipment safety is called reliability engineering. It has its own scientific society. But this is not a flashy field, and it is one in which a scholar must have patience and perseverance. If everything goes right, then the results are only as expected. But it can be a disaster if there is a breakdown.

The Japanese H1 rocket has never had a failed liftoff. Its 100 percent successful launch rate makes it the envy of the world. In order to come this far from the original Tokyo University "pencil rocket", a long process of endurance and trial-and-error was needed. The pencil rocket failed many times, and each time the press would say that a "fundamental error" had occurred. As one of those involved in the project in those early days, I remember the chagrin we felt even today.

We were going to launch a rocket without relying on technology from any other country in the world. The process of achieving this involved any number of areas of which those involved in the project knew nothing about. When we finally arrived at the stage for actual tests, we experienced one failure after another. In many cases, we later found out that the failure had been caused by a quite trivial problem. I can understand the criticism of our problems as "fundamental," the true feeling of those taking part in the development process was a desire to discover how many "trivial problems," which could not be uncovered except through testing, there were.

Once when a rocket stage detached, the stage, which we thought would just fall away, actually had some propulsive force remaining and rear ended the main stage. This caused one test to end in failure. The newspapers and other media asked "why couldn't they have anticipated a problem like this?"

But afterwards, when a director of the Japanese Space Aeronautics Laboratory visited NASA, it is said that one of the NASA directors comforted him, saying "so you made the same mistake we did?" In their many trips to NASA, this was the first time someone associated with the Japanese project was told of such as failure. But when the news of a Japanese failure got to America, their attitude changed. We were finally recognized as having come of age.

This is a not inconsiderable number of people who view Japan's space development efforts with indifference. This is because the H2 rocket, the successor to the H1, experienced repeated failures at liftoff. One often hears the opinion that "we shouldn't have spent all that money on that thing."

But it is also a fact that the more failures we experience, the more of a mutual understanding we build with foreign engineers. It is a big mistake to think that we can just buy the technology if we offer the right price. In particular, it can be said that the knowhow gained from successive failures is everything when it comes to reliability engineering.

When first introduced, bad things were said about the Nozomi and the Yamagata mini-bullet train. If everything goes right, then the results are only as expected. But if a mishap occurs, everyone gangs up on you with criticism. I hope that the people involved would understand clearly that this is their fate. The joy they feel when the train runs smoothly is something that other's cannot comprehend. They feel this joy when we see the Nozomi and the Yamagata mini-bullet train full to capacity with passengers returning to their hometowns during summer vacation. When there are no reports of serious accidents, I want to tell everyone involved "good job." After successfully completing seven years of testing and making many tiny improvements, the Nozomi was finally introduced in large numbers. I'd like to let out a yeil of encouragement.

An Age in Which Technology Takes Precedence over Politics
-- Lessons of the Japan-U.S. semiconductor issue

The concentration of all important functions in Tokyo has become a problem in Japan, and there is talk of moving the governmental functions to a different area, as is the case with Washington, D.C. I told an American friend about this at a conference held in Washington in June of last year (1991). He replied as follows: "Oh, don't do that! Washington has nothing but government. So whenever an issue is considered, it is considered from a political viewpoint. This results in a lot of talk that is divorced from reality and intended only for public consumption. Don't you have the expression 'political pronouncement' in Japan? Tokyo is much better than Washington. You have everything in one place: government, economics, and culture. And it is also a place where a large populace lives. That means that even if there is a certain amount of odd political wrangling, it is seen through right away. You have a corrective function operating. If government functions alone are to be separated, try moving them to somewhere that is really isolated. Japanese politics will become really bizarre."

Our discussion continued, centering around this topic, and then a second important point was made. Namely, that the hoards who descend on Washington are all the pawns of corporations that are not doing well. If one does not keep this in mind when listening to the talk that comes out of Washington, you will completely misunderstand what they are saying. Well-run corporations stay away from Washington, because getting involved there costs a lot of money.

Once I was told this, I realized that it was true. It may not be true that all of the people who go to Washington to press their case with congressmen are losers, but there is no doubt that they are plotting something. Of course they try to hide their intentions behind honeyed words, but in the end what they are doing is clear. Nevertheless, if one does not consider very carefully what their true intentions are and ask appropriate questions accordingly, it may be impossible to put things right later on.

If one carefully examines each statement one hears from Washington with this point of view, the meaning becomes crystal clear.

But one must be careful because there are people who come from Japan and draw the attention of the congressmen in

Washington to things they had not even been thinking about. Last year (1991) was the fiftieth anniversary of the attack on Pearl Harbor. The media in Japan carried a variety of news stories on this theme. A congressman whom I know well gave me a bitter smile and spoke to me frankly. "To tell the truth, I had forgotten that this was the fiftieth anniversary. Then all of a sudden a bunch of Japanese TV reporters showed up and asked for my comments on the matter. I couldn't just say that I'd forgotten about it, so I told them a little bit about those days. But the interviewer was not satisfied. He went and asked me if I thought Japan was ungrateful and had become arrogant. Isn't this a case of match pump? You seem to know the head of that TV station, so go tell him what I said."

At any rate, it had already been ten years since we became involved in the problem of trade friction between Japan and the United States. And now the semiconductor dispute, which was once such a noisy issue, had quieted down. The reason is simple. Cooperation between Japanese and American manufacturers has become very close, and even the companies that were taking the hardest stance against Japan now have joint link-ups with Japanese corporations.

In other words, the representatives of the government in Washington wanted to do something to Japan, but before they knew it their cheerleaders had disappeared.

This July, a symbolic announcement was made on international technical cooperation. Toshiba of Japan, I.B.M. of the United States, and Siemens of Germany reached a joint development agreement regarding the development of the next generation of semiconductors.

America was beaten by the Japanese semiconductor industry, so a research consortium called SEMATECH was formed with the backing of the Department of Defense in order to spur industrial technology development. The core presence in this consortium is I.B.M. Also, in like manner the EC (European Community) has formed an organization called JESSI, financed by the governments of the various EC nations. Siemens is one of the most powerful members of this organization. Then in July the above-mentioned three-company joint development agreement was announced.

This means that the establishment of both SEMATECH and JESSIE now have no significance.

The world of technology knows no pity. It is not possible to raise the technological level of one's company by enlisting the aid of the government and putting pressure on Japan. The progress of technologies such as semiconductors is swift, and in such cash-hungry industries, it is essential to develop the next generation of technology as fast as possible and put out new products faster than the competition or you will go under. The American manufacturers have learned this lesson and all at once decided to join hands with Japanese corporations. In other words, they realize that rather than going to Washington to complain, if they don't go to Japan and form an alliance with somebody, their companies will have no future.

This is an important new situation for viewing future international relationships. In fact the principles of economics are now taking precedence over politics.

In the Cold War period, introducing technology into your own country was the top priority in order to ensure national survival. But times have changed. If you are not aware of these changes and continue to think of things in terms of politics-first, you will be left behind. This is an age in which technology takes precedence over politics.

Mold Technology Is the Sustenance That Supports the

Manufacturing Industry.

One basic manufacturing technology is molds. Molds are essential to stamp or bend metal, and to mold plastic. But designing molds relies largely on experience. You can't learn how to design a mold just by studying textbooks. Japanese manufacturers have an acknowledged reputation for their excellence. And this reputation for reliability is supported by their superior mold technology. Some time ago, Germany (the former West Germany) would be mentioned when there was talk of molds. But today Japan is the clear leader in this field.

It is a surprisingly little-known fact that the press molds used by Ford in the United States to manufacture their Lincoln luxury cars are supplied by a Japanese manufacturer. This Japanese manufacturer has a 3,000 ton press that it uses to test finished molds. Ford buys not only the molds, but parts processed using this giant press as well.

The rise of Japanese mold technology to the number one position in the world is largely due to advances in CAD/CAM (computer aided design and manufacturing). These advances have greatly reduced the time required to deliver the finished product. It is no wonder that clients are pleased when something that used to take six months can now be finished in three.

Once a mold is made, it is often necessary to make corrections when one comes to the actual stamping stage. The ability to make these corrections freely by computer has also contributed to the competitiveness of Japanese manufacturers. Now orders pour in not only from Japan, but from overseas as well.

If in addition to CAD/CAM, Japan's excellent NC (numerical control) technology is applied, products can be manufactured to micron (one one-thousandth of a millimeter) level tolerances. To someone like me who is familiar with how things were in the old days, it seems like a dream come true.

With the technology advanced to this point, mold manufacturers who do things the old way -- drawing designs by hand -- cannot survive.

In Germany, the apprentice system still remains as a strong presence. It would appear that it is difficult to replace human knowhow, which was their most precious asset, with computers in such an environment. Their slowness in adapting to CAD/CAM is one of the biggest reasons for the collapse of the German mold manufacturers.

But what about America, you say?

As I was looking at statistics on machine tools the other day, I saw that America, which had boasted the world's top production volume in 1981, has now dropped to number five.

The American machine tool industry entered its peak period from about 1974 onward. It is said that this was the first or second most profitable industry in the United States.

The industrial world was subsequently overtaken by a rash of corporate mergers and acquisitions (M&A). Many of the machine tool manufacturers were small- or medium-sized companies, making them tempting targets for buyouts. They were snapped up one after another by large conglomerates in purchases of publicly offered stocks (takeover bids).

However, the favorable conditions in the machine tool industry began to change for the worse around 1982. This led to downsizing of workforces and organizations, and in some cases complete abandonment of the field, in the name of "elimination of non-performing sectors."

The American manufacturers were unlucky in that this was precisely the period when NC was gaining ground. In the

United States, where rationalization was the word of the hour, companies neglected to keep up with this new technological revolution, and the various manufacturers eventually lost their ability to compete.

Up until this point, the Japanese manufacturers have been on the right track. But technology continues to advance. If the Japanese manufacturers try to maintain the status quo, they will be left behind. And in the mold industry, where human experience is the most precious asset, investment in personnel is everything.

For several years now, the term the "three D's" (dirty, dangerous, demanding) has been a popular buzzword. Young job seekers have been avoiding the mold manufacturers.

Japan's superb mold technology is the foundation of Japan's manufacturing industry. It is the true sustenance of that industry. You might have lots of semiconductors, but without molds production will not advance. This year on the hiring front, it is buyer's market for the corporate side. I hope that those in the mold industry will make the most of this opportunity.

Industry Should Offer Bold Cooperation to the Clinton

Administration.

President-elect Clinton devoted many pages in his campaign literature to science and technology policy. It argues the following: In order to achieve a more prosperous life for our children and grandchildren, strong policies promoting science and technology are needed. In addition, if we can combine America's abundant natural resources with superior technology, we can build the world's most prosperous economy.

According to these materials, one half of the applications for U.S. patents last year (1991) were made by foreign corporations. In addition, five Japanese companies were among the top ten. In contrast to Japan's 662 billion dollars in investments in plant and equipment, the total for American corporations was just 550 billion dollars. Since the Japanese economy is 60 percent as large as the American economy, these figures clearly highlight the strength of Japanese investment in plant and equipment. If things remain like this, the competitiveness of the American manufacturing industry will continue to decline.

In this manner, the campaign literature uses Japan as a basis for comparison in every imaginable field, and calls out to the American public to make the United States more competitive.

This argument should not be dismissed as mere campaign rhetoric. The Clinton administration will of course begin to lower taxes on investment, and will probably also beef up aid for technical development in the industrial sector. Also, these materials also touch on the issue of education. The most popular fields among university students are law and art. In contrast, fields such as physics and engineering are among the least popular. What's more, many of those interested in studying science and technology are foreign students. Most of them return to their homelands as soon as they graduate. This makes the shortage in the United States of graduates in science and technology related fields even clearer. These types of issues were rarely brought up in past presidential election campaigns.

When President-elect Clinton touched on the issue of the trade imbalance between Japan and the U.S. during the campaign, he clearly stated that he though three-quarters of the blame belonged to the United States. Reading this text, which is really a collection of comments made during the campaign, it becomes clear that Clinton has a clear grasp of America's problems and is trying to find a way to break out of the vicious circle that has prevailed until now. In addition, the content of the text is powerful. The word "Japan" appears eleven times in this short 17-page pamphlet. And Japan is cited as an example of success.

But the problem is the reaction in Japan to such a Clinton Administration. The news and other sources contain many arguments in which Japan sees herself as a victim, and state that it is likely that pressure on Japan, both tangible and intangible, is sure to increase. But Clinton is saying that he wants America to learn from Japan.

Professor Deming, the authority on quality control, is another person who is alarmed at the decline in competitiveness of American corporations. Using the Baldridge Award which is awarded to American corporations with excellent total quality management (TQM) programs, as an example, he argues that American companies need to work harder on the quality control problem. Many examples of successful Japanese corporations appear in Professor Deming's work as well. He says America must learn from Japan.

It made me very happy to read these materials because they are saying the same things I did in my book "Frank Talk for the Hollowing American Economy," which was published by the PHP Research Institute in 1985. I'm not saying that I'm a great doctor. It is only natural that different doctors would come to the same diagnosis after examining the same patient.

When I hear a thesis such as the preceding, I feel that I must urge Japanese corporations to do their utmost to assist American industry revitalize itself. Today, with the end of the Cold War, a shift in emphasis to the economic field is occurring in the United States and in other countries around the world.

Many object to cooperation with the United States in the area of security, but there shouldn't be as much resistance to cooperation in the economic field, should there? Japan, which had become one of the poorest countries in the world after the Second World War, soon became a developing country and now is one of the world's preeminent economic powers. Much of this progress was accomplished thanks to American assistance. We should cooperate in a substantial way with the efforts of the Clinton Administration, partly as a way of repaying our debt of gratitude.

Happily, TQM is also being adopted by Japanese companies and is achieving significant results. In addition, there are many areas of technology where America frankly acknowledges the superiority of Japanese corporations. I propose that the people of Japan agree to build a cooperative relationship with the United States in these areas.

In answer to a position such as mine, some will say that I do not fully grasp the realities of the situation with regard to international politics and international competition between corporations. But the world is changing rapidly. I have great expectations regarding Clinton's youth, and I feel that showing the intention to cooperate is a sound plan for the next one hundred years.